NUREG-1078

# Environmental Impact Appraisal
for renewal of
Special Nuclear Material
License No. SNM-1097

Docket No. 70-1113

General Electric Company
Wilmington Manufacturing Department

**U.S. Nuclear Regulatory Commission**

**Office of Nuclear Material Safety and Safeguards**

June 1984

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## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| ADU | Ammonium Diuranate $UF_6$ to $UO_2$ Conversion Process |
| ALARA | As low as reasonably achievable |
| AMAD | Activity median aerodynamic diameter |
| CEQ | Council on Environmental Quality |
| CFR | Code of Federal Regulations |
| EIA | Environmental Impact Appraisal |
| EIS | Environmental Impact Statement |
| EPA | Environmental Protection Agency |
| GE | General Electric |
| GECO | GE $UF_6$ to $UO_2$ Conversion Process |
| HEPA | High efficiency particulate air |
| ICRP | International Commission on Radiological Protection |
| NEPA | National Environmental Policy Act |
| NPDES | National Pollutant Discharge Elimination System |
| NRC | Nuclear Regulatory Commission |
| RCRA | Resource Conservation and Recovery Act |
| UPMP | Uranium Process Management Project |
| UPS | Uranium Purification System |
| URLS | Uranium Recovery Lagoon Sludge |
| $\chi/Q$ | Atmospheric Dispersion Factors |

# 1. PURPOSE OF AND NEED FOR THE ACTION

## 1.1 Introduction

The General Electric (GE) Company Fuel Fabrication Facility near Wilmington, North Carolina produces fuel for commerical light-water nuclear reactors. This operation includes the conversion of uranium hexafluoride ($UF_6$), normally enriched in the U-235 isotope up to 4%, to uranium dioxide ($UO_2$). The $UO_2$ powder is pressed into pellets and loaded in Zircaloy tubes which are then assembled into fuel bundles. The possession and use of these and other nuclear materials are controlled in accordance with regulations of the U.S. Nuclear Regulatory Commission (NRC), "Title 10, Code of Federal Regulations, Part 70" (10 CFR 70).

In response to an applicantion (July 25, 1983) by GE for renewal of Special Nuclear Material License No. SNM-1097, the U.S. Nuclear Regulatory Commission (NRC), with the technical assistance of Science Applications, Inc., prepared this environmental assessment pursuant to Council on Environmental Quality (CEQ) regulations (40 CFR Parts 1500-1508) and NRC regulations (10 CFR Part 51), which implement requirements of the National Environmental Policy Act (NEPA) of 1969 (P.L. 91-190). Paragraph 1508.9 of the CEQ regulations (40 CFR) defines "environmental assessment" as follows:

1. An environmental assessment is a concise public document, for which a federal agency is responsible, that serves to

   - briefly provide sufficient evidence and analysis for determining whether to prepare an Environmental Impact Statement (EIS) or a finding of no significant impact,

   - aid an agency's compliance with the Act when no EIS is necessary, and

   - facilitate preparation of an EIS when one is necessary.

2. An environmental assessment shall include brief discussions of the need for the proposal, of alternatives as required by Sect. 102(2)(E) of NEPA, and of the environmental impacts of the proposed action and alternatives. It shall also include a listing of agencies and persons consulted.

## 1.2 License History

License No. SNM-1097 was first issued to GE for operations at the Wilmington Plant on January 1, 1969, and fuel manufacturing activities began soon thereafter. In January 1974, in support of an application for renewal of this license, GE submitted an environmental report which describes the plant's impacts on the environment during its first five years of operation.[1] The license was renewed on December 24, 1976, following the issuance of a negative declaration and EIA by the NRC in June 1975.[2] This new license was to have expired in May 1981, but GE filed a renewal application that fell under the

timely renewal provision of 10 CFR 70.33. GE continued operations under timely renewal until February 1, 1983, when the NRC amended License SNM-1097 to include revised license conditions and established a new expiration date of January 31, 1984. On July 25, 1983, GE requested renewal of the amended license. This request was supported by a new Environmental Report which emphasizes the environmental impacts of plant operations during the years 1978-1982.[3]

## 1.3 Description of the Proposed Action

The proposed action, the full 5-year renewal of License SNM-1097, is necessary for GE to continue producing fuel used in light-water nuclear reactors. The fuel manufacturing operation principally involves converting $UF_6$ to $UO_2$ powder, pressing the $UO_2$ powder into pellets, sintering and grinding the pellets, loading the pellets into Zircaloy tubes, and then assembling the loaded tubes into fuel bundles. A variety of radiological and nonradiological gaseous, liquid, and solid wastes are generated. After treatment, some of the wastes are released to the environment. In addition to the nuclear fuel fabrication operation, there are other operations performed at GE which do not require NRC licensing (e.g., zirconium metal processing, production of fuel bundle and mechanical reactor components, and the manufacture of aircraft engine parts) and are not associated with the proposed action.

## 1.4 Need for the Action

Although orders for new reactors have decreased in recent years, the nuclear fuel industry is continuing and is important in filling the total power needs of the nation. As long as the current demand for nuclear energy continues, the fuel production rate must keep pace. The role of GE's Wilmington plant in the overall fuel cycle is shown in Figure 1.1.

The GE fuel manufacturing operation produces assembled $UO_2$ fuel bundles for light-water reactors and $UO_2$ products for other fuel fabricators. GE is currently a major supplier of fuel for boiling water reactors throughout the world and denial of its license renewal would only be considered if issues of public health and safety could not be satisfactorily resolved.

## 1.5 Scope of Review

The staff's environmental review of GE's request for license renewal included an evaluation of their waste treatment and disposal practices, effluent and environmental monitoring programs, and recent monitoring data. The Wilmington plant site was visited by members of the NRC staff to discuss environmental questions related to the renewal and, when necessary, GE submitted written responses to the questions. The license application and supporting environmental information have been discussed with NRC's Region II office in Atlanta and their staff views and concerns have been addressed in the review. The Wilmington Regional Office of the North Carolina Department of Natural Resources and Community Development was also visited by NRC staff to discuss the State's effluent and environmental permit programs at the GE site. The State's comments have also been incorporated into this EIA.

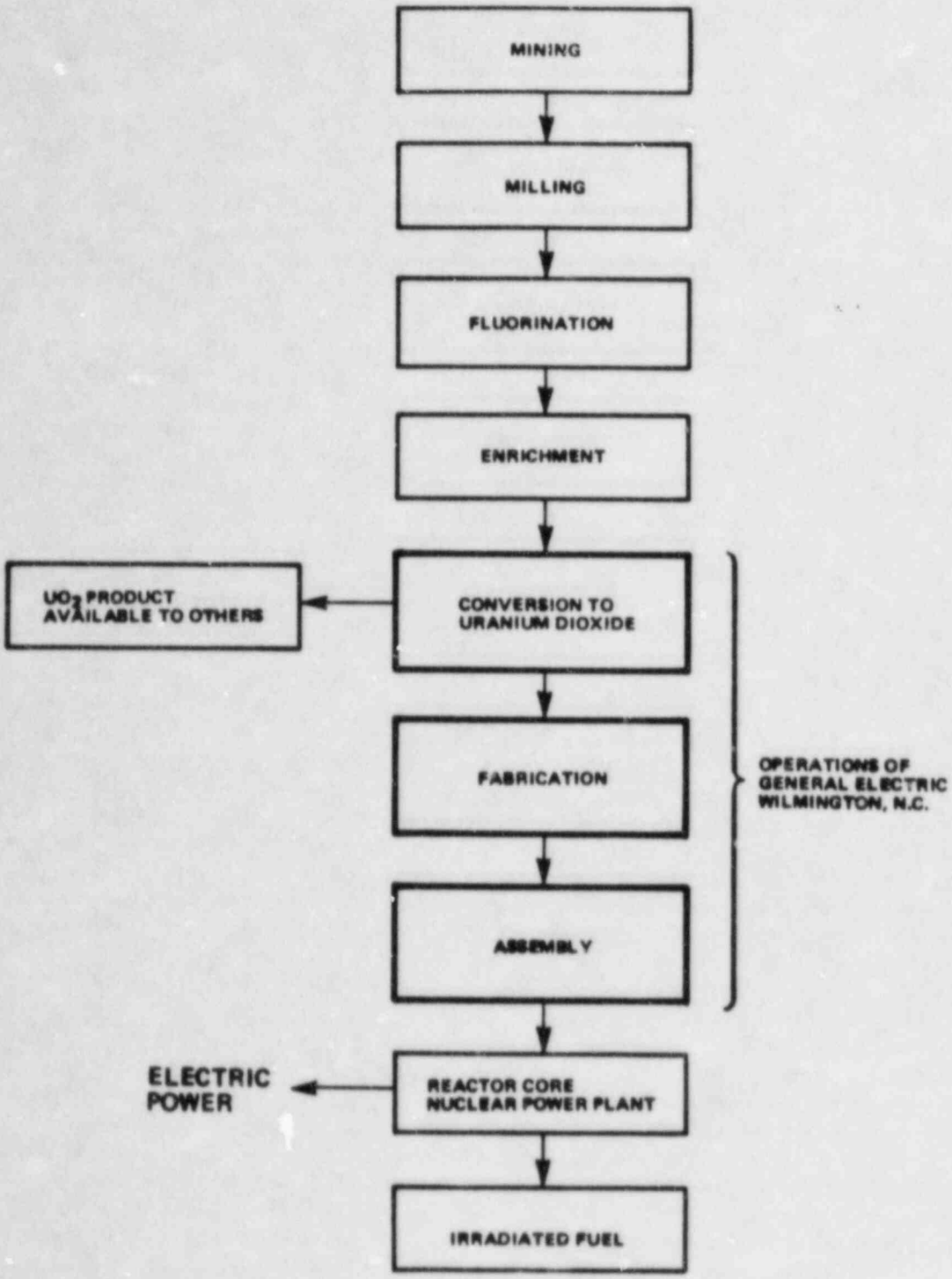


Figure 1.1 Nuclear fuel cycle and role of the GE plant

## 2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

### 2.1 The Alternative of No License Renewal

The alternative to the proposed action authorizing renewal of the license for GE's Wilmington plant is to deny renewal of the license. This alternative action would cause the Wilmington plant to cease nuclear fuel manufacturing operations.

The fuel produced in the Wilmington plant is sold commercially in a competitive market to supply the fuel requirements for operating nuclear reactors. As stated in Section 1.4, the Wilmington plant is a major supplier of fuel in the U.S. and throughout the world. Consequently, it can be assumed that the same quantity of fuel would be produced at some other location if the Wilmington plant were to close. The plant has operated from 1969 to the present time and, as discussed in Sections 2.2 and 4, the impacts of plant operations on the environment have been small and acceptable. The effects of continued operation are also expected to remain small. If the fuel production activities were to be performed at another location, no significant reduction in overall environmental effects from fuel production activities would be expected to result.

### 2.2 The Alternative of License Renewal

This alternative, which is the proposed action, would be the continued operation of the GE fuel manufacturing operation essentially as it has been conducted for the past six years. Within the general alternative of license renewal, alternatives to certain portions of GE's waste confinement and effluent and environmental monitoring programs can be considered. The remainder of Section 2.2 is a description of GE's current operation, waste confinement, and effluent control systems. The environmental impacts of these operations, as well as alternatives to GE's operation that may reduce future impacts, are discussed in Section 4.

#### 2.2.1 Description of Current Operation

The GE plant is located in New Hanover County, North Carolina, about 6 miles north of Wilmington (see Figures 2.1 and 2.2). The developed portion of this site including major buildings and facilities are shown in Figure 2.3. There are four main buildings on the GE grounds. The Fuel Manufacturing Building is where uranium is processed to produce fuel rods and assemblies. This building also houses chemical, process, and metallurgical laboratories. Small quantities of uranium may be temporarily moved to other buildings or site locations for special tests, but these other buildings are normally used for activities that do not require NRC licensing. The Fuel Components Building is used to process zirconium metal for the production of fuel bundle parts, the Equipment Manufacturing Building is where non-fuel components for reactors are produced, and jet engine parts are fabricated in the Aircraft Engine Manufacturing Building.

Liquid wastes produced from the fuel manufacturing operations are initially directed to the Waste Treatment Facility which includes a series of lagoons. After initial treatment there, some of the liquid wastes are then transferred

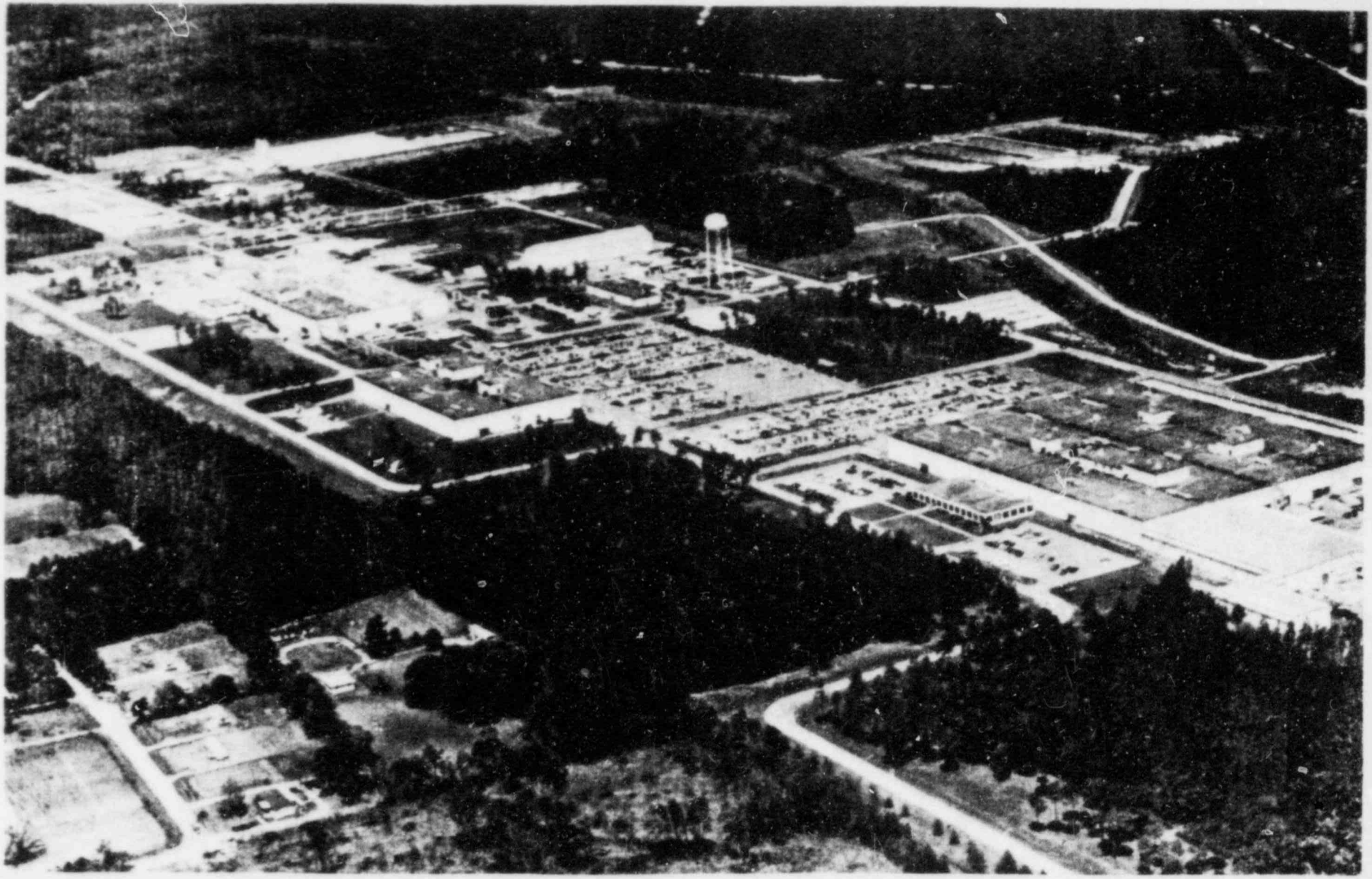

Figure 2.1 Aerial view of the GE plant

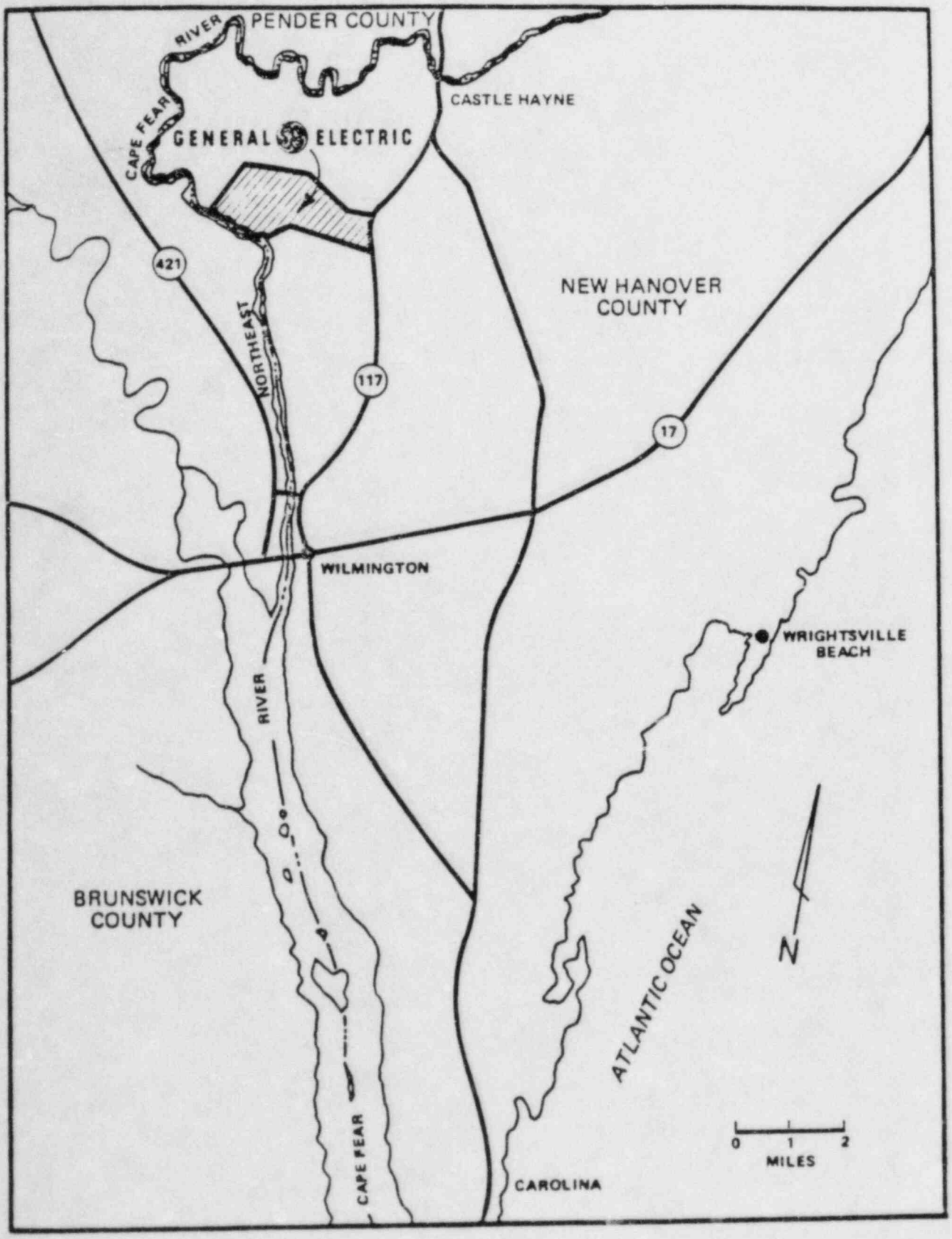


Figure 2.2 Plant site - New Hanover County and adjacent counties

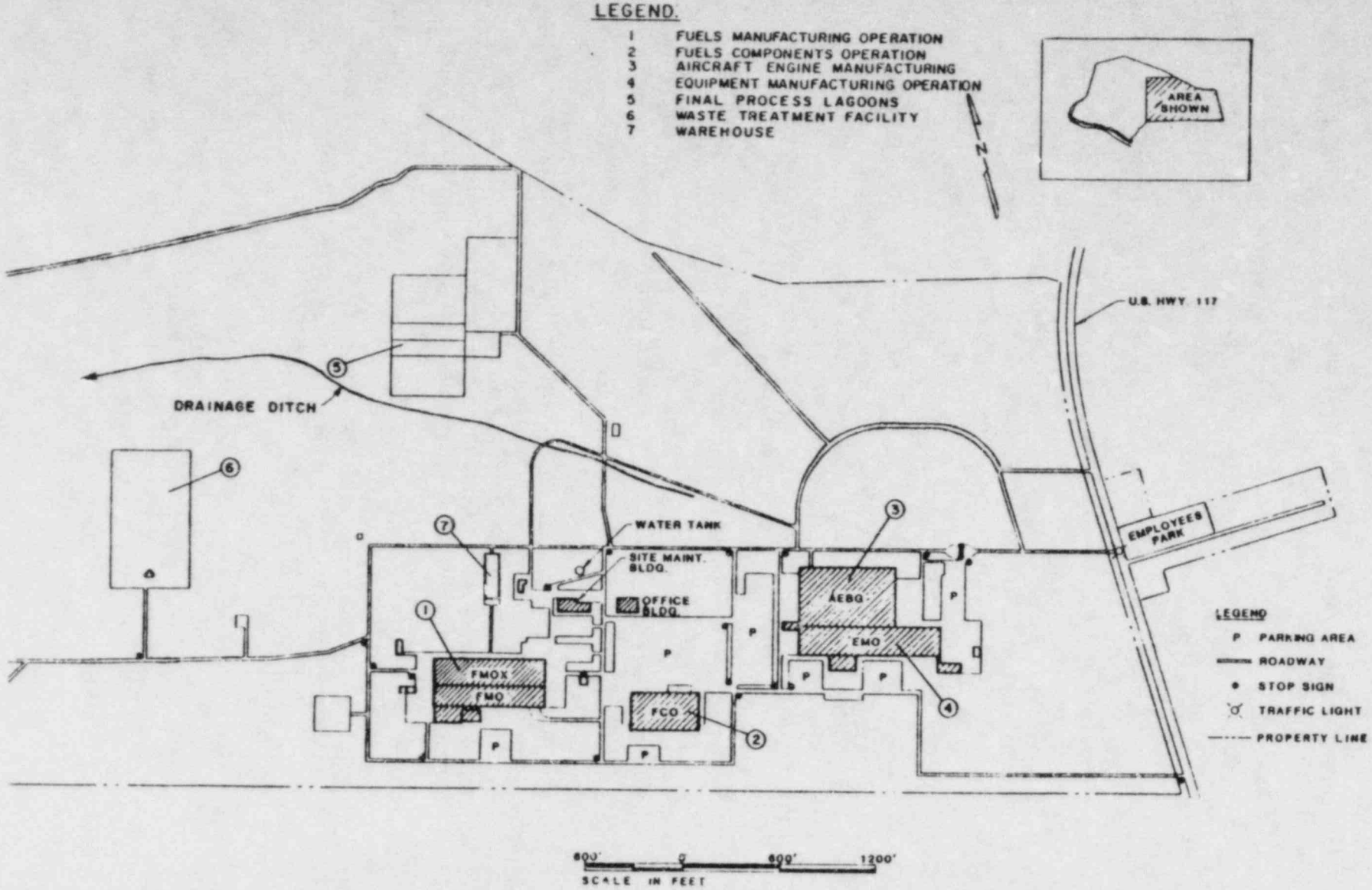


Figure 2.3 Major buildings and facility grounds

to the final process lagoons which outfall into the main site drainage ditch and eventually to the Northeast Cape Fear River.

The series of unit operations used in the fuel manufacturing operations is shown in Figure 2.4, and each of the major steps is described separately below.

2.2.1.1 $UF_6$ to $UO_2$ Conversion

$UF_6$, normally enriched in U-235 up to 4 wt %, is removed from shipping cylinders by placing the cylinder into a heated chamber where the solid $UF_6$ is vaporized. The $UF_6$ gas is either converted to ammonium diuranate (ADU) in a wet chemical process or to a mixture of $U_3O_8$ and uranyl fluoride ($UO_2F_2$) in a dry, direct conversion (GECO process) patented by GE. The Wilmington plant is equipped with three conversion lines using the ADU process and four lines that use the direct GECO process.

A. Ammonium Diuranate Process

The conversion of $UF_6$ to $UO_2$ by the ADU process involves the steps outlined in Figure 2.5. Vaporized $UF_6$ is reacted with deionized water to form an aqueous solution of uranyl fluoride ($UO_2F_2$) and hydrofluoric acid (HF). ADU is precipitated by contact with ammonium hydroxide ($NH_4OH$). The ADU is separated from the water in a dewatering centrifuge. The solid phase (ADU) is routed to a defluorinator-calciner where it is dried and reduced to $U_3O_8$. The powder is reduced to $UO_2$ in a second calciner under an atmosphere of hydrogen ($H_2$). The liquid from the centrifuge is processed through a second centrifuge to remove additional ADU. The liquid is stored in a quarantine tank, assayed, and routed to the waste treatment system. In the event that the waste liquid contains recoverable amounts of uranium, it is recycled for additional purification.

B. GECO Process

The GECO process involves steps shown in Figure 2.6. $UF_6$ gas is directed to a heated chamber where $H_2$ derived from cracked ammonia and oxygen from air react with the $UF_6$ to form a mixture of solid $UO_2F_2$ and $U_3O_8$. The hot reaction products are routed to porous metal filters where the uranium powders are recovered from the gas stream. The uranium powders are defluorinated with steam and reduced to $UO_2$ with hydrogen in a calciner. The product $UO_2$ is recovered as a powder in 5-gallon cans. Offgasses from the porous metal filters are condensed to produce a useable hydrofluoric acid solution. This recovery of HF reduces the amount of fluoride wastes produced. The offgas from the defluorinator-calciner is scrubbed and discharged into the exhaust system.

2.2.1.2 Pellet Forming Process

The $UO_2$ powder from either of the conversion processes is blended for density control, isotopic adjustment, and product homogenation. After blending, the powder is pressed into pellets slightly larger in diameter than is required. The pellets are sintered in a furnace under a reducing atmosphere and then ground to the specified diameter in centerless dry grinders. The pellets are then inspected and stored.

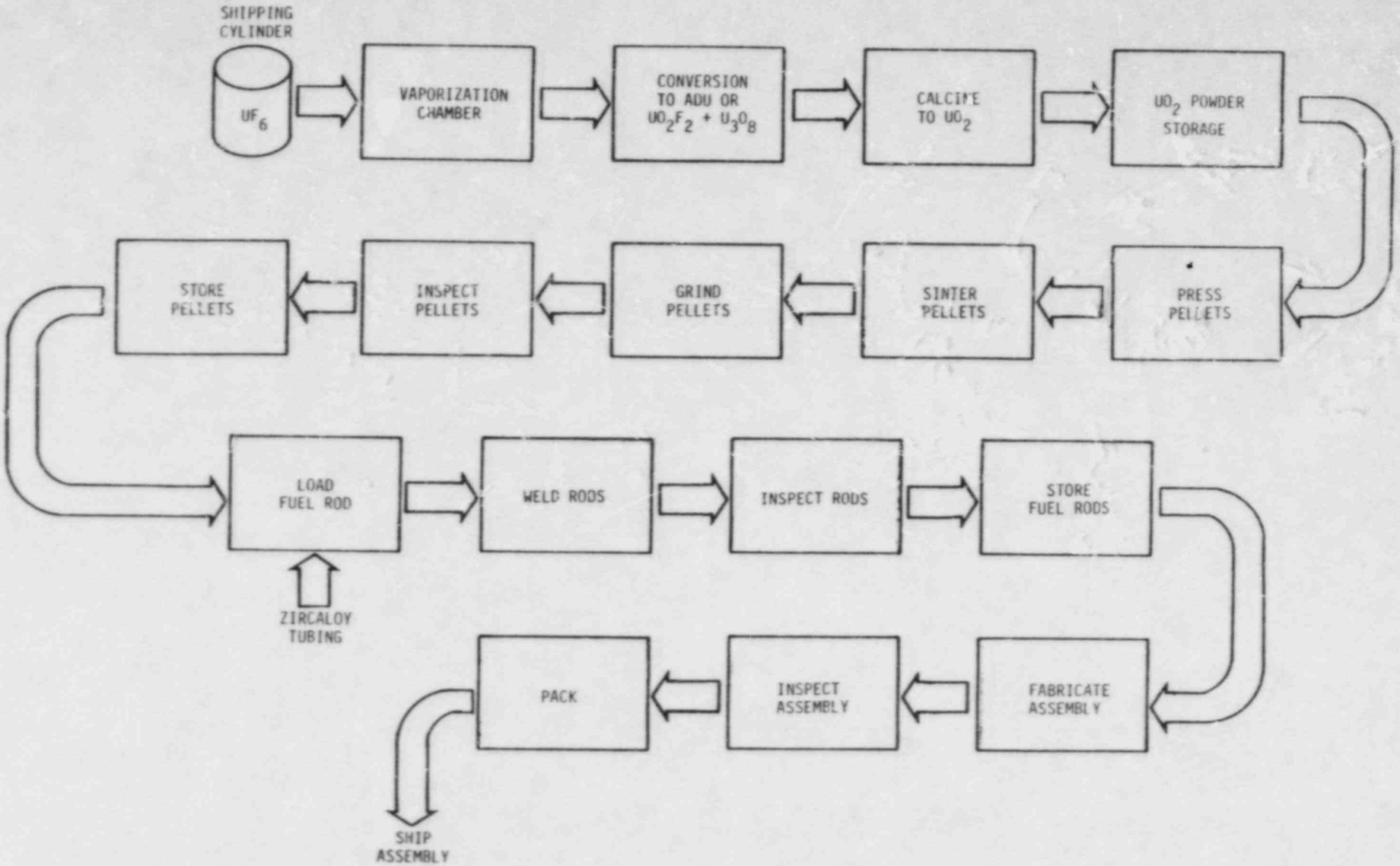


Figure 2.4 Fuel manufacturing operation block flow diagram

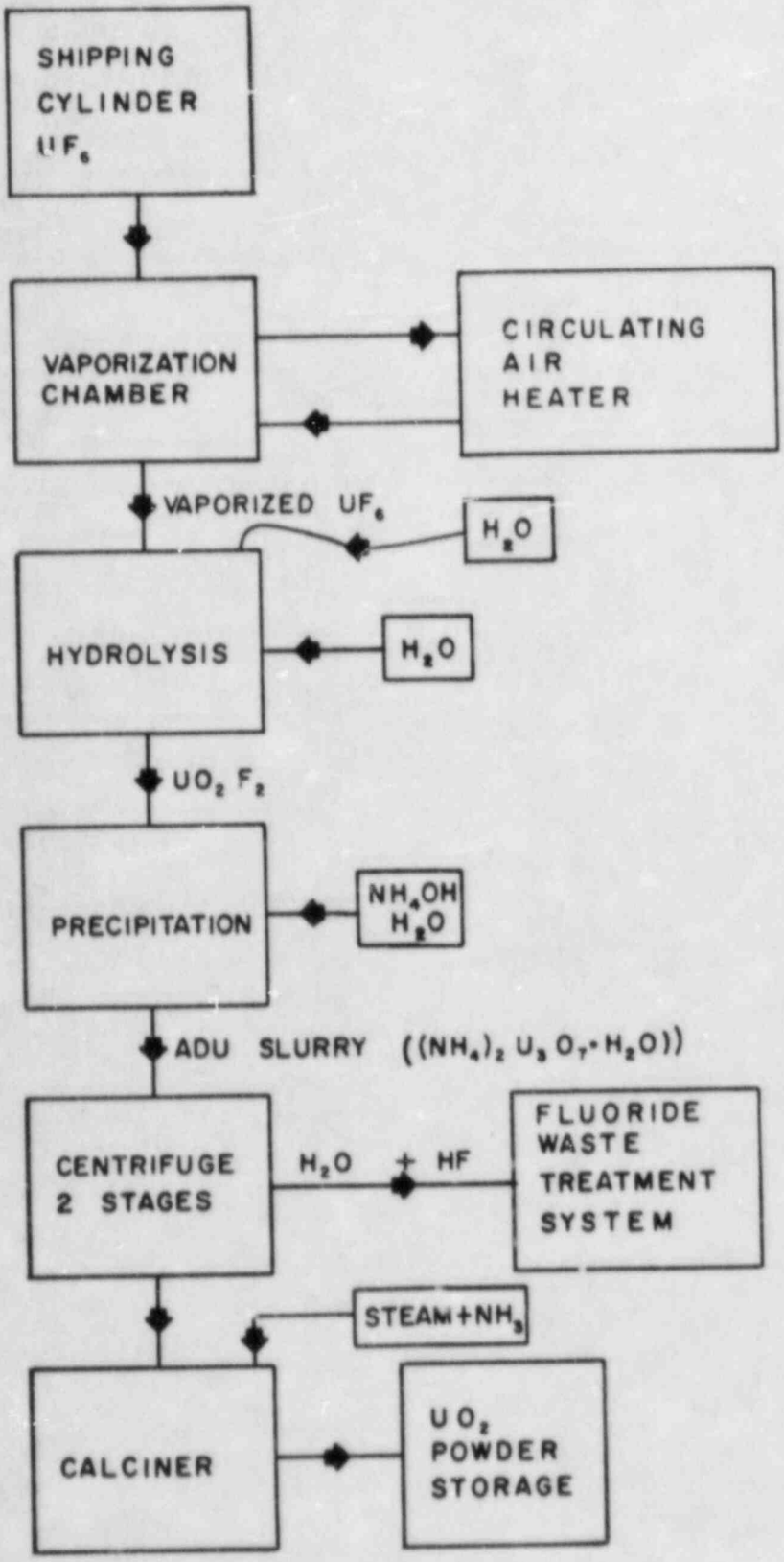


Figure 2.5 ADU conversion process

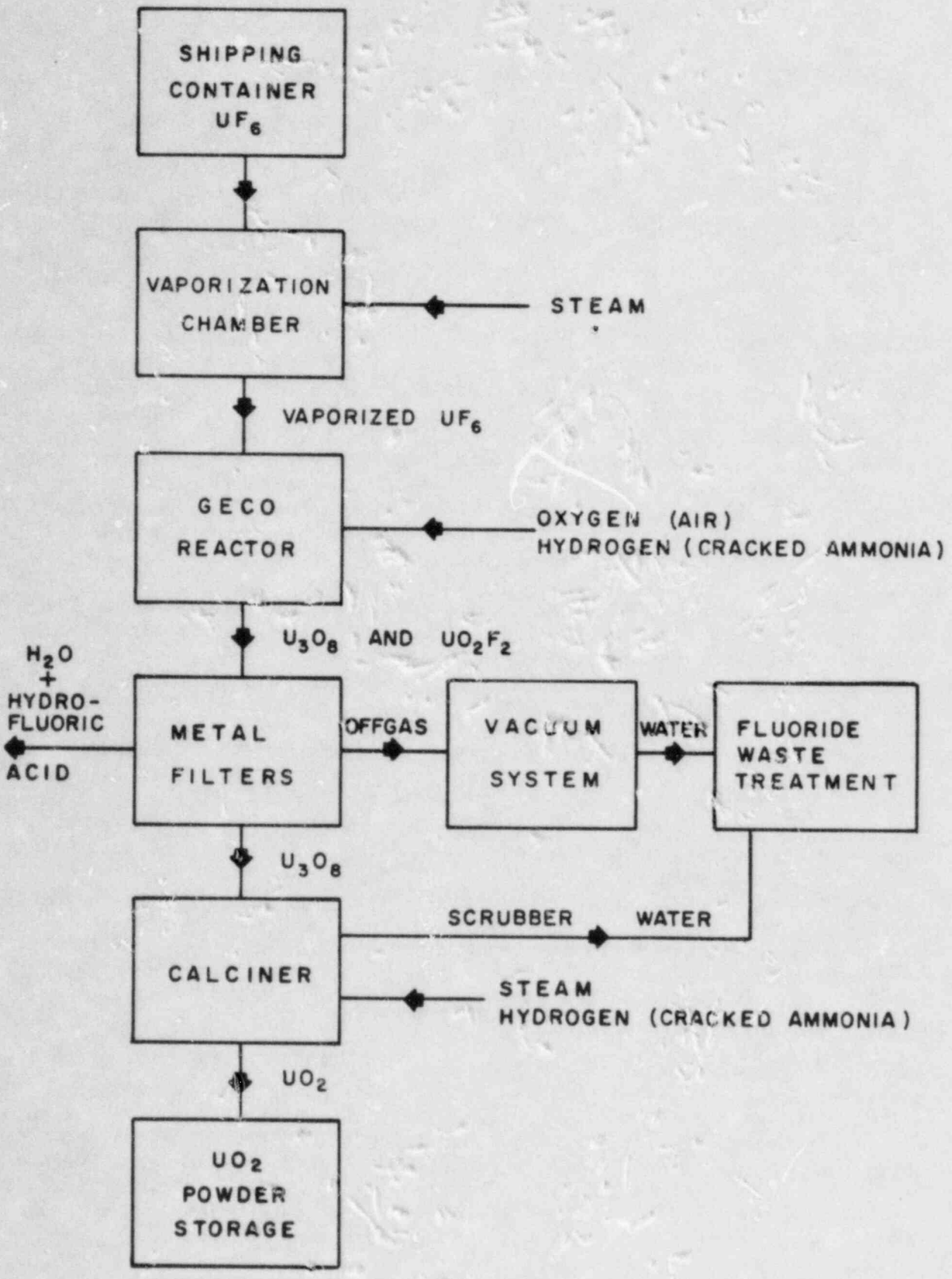


Figure 2.6 GECO conversion process

### 2.2.1.3 Rod Fabrication and Fuel Bundle Assembly

The pellets are loaded into Zircaloy tubes that already have the first end plug welded into place. After loading, the rods are outgassed in ovens and the closing end plug is seal welded. The fuel rods are cleaned, inspected, stored, and then manually assembled with fuel element spacers and end fittings to form fuel bundles. Finished fuel bundles are inspected and packed into shipping containers.

### 2.2.1.4 Uranium Purification System

An important component of GE's fuel manufacturing operation which is not shown in Figure 2.4 is the Uranium Purification System (UPS). The steps involved in the UPS are outlined in Figure 2.7. Scrap and other process materials containing uranium which do not meet the required specifications are routed to the UPS for uranium recovery. The materials are dissolved in nitric acid ($HNO_3$) to form a solution of uranyl nitrate [$UO_2(NO_3)_2$]. Hydrogen peroxide ($H_2O_2$) and ammonium hydroxide ($NH_4OH$) are added to precipitate the uranium as the tetroxide ($UO_4 \cdot 2H_2O$). The resulting slurry is dewatered in a centrifuge. The tetroxide is dried and calcined in a furnace with a reducing atmosphere to form $UO_2$ powder, which is returned to the main process.

The Wilmington plant is equipped with one dedicated UPS process line. If the requirements for scrap recycle warrant, one of the ADU process lines can be adapted to recover uranium from scrap materials.

### 2.2.1.5 Water Supply and Consumption

The GE plant is located beyond the service area of the Wilmington Water District. Consequently, the water supply for the plant is provided from a series of 15 wells penetrating an aquifer underlying the plant. These wells have been approved by the North Carolina Department of Natural Resources and Community Development. The aquifer is estimated to have an available water supply of 10 million gallons per day.[4] The annual water usage at the plant since its start up has ranged from 208 to 310 million gallons with a 14-year average of about 250 million gallons per year.[3] During the years with the maximum usage, the average daily consumption was about 1 million gallons or less than 10% of the available water supply. Therefore, water withdrawal rates to support GE activities are not expected to have significantly affected the water level in the aquifer.

About 92% of the water withdrawn from the wells is eventually discharged to an onsite drainage ditch that outfalls into the Northeast Cape Fear River.[3] There are no known direct users of the river water downstream of the GE plant outfall. The liquid waste is treated in a series of lagoons before discharge and its quality at the point of release is controlled by both the NRC and the State of North Carolina (Sections 2.2.2.2 and 4.1.1.2). The portion of water that is not released in this liquid waste stream is either shipped offsite or reused (in accordance with NRC licensing), lost through evaporation, or consumed as potable water.

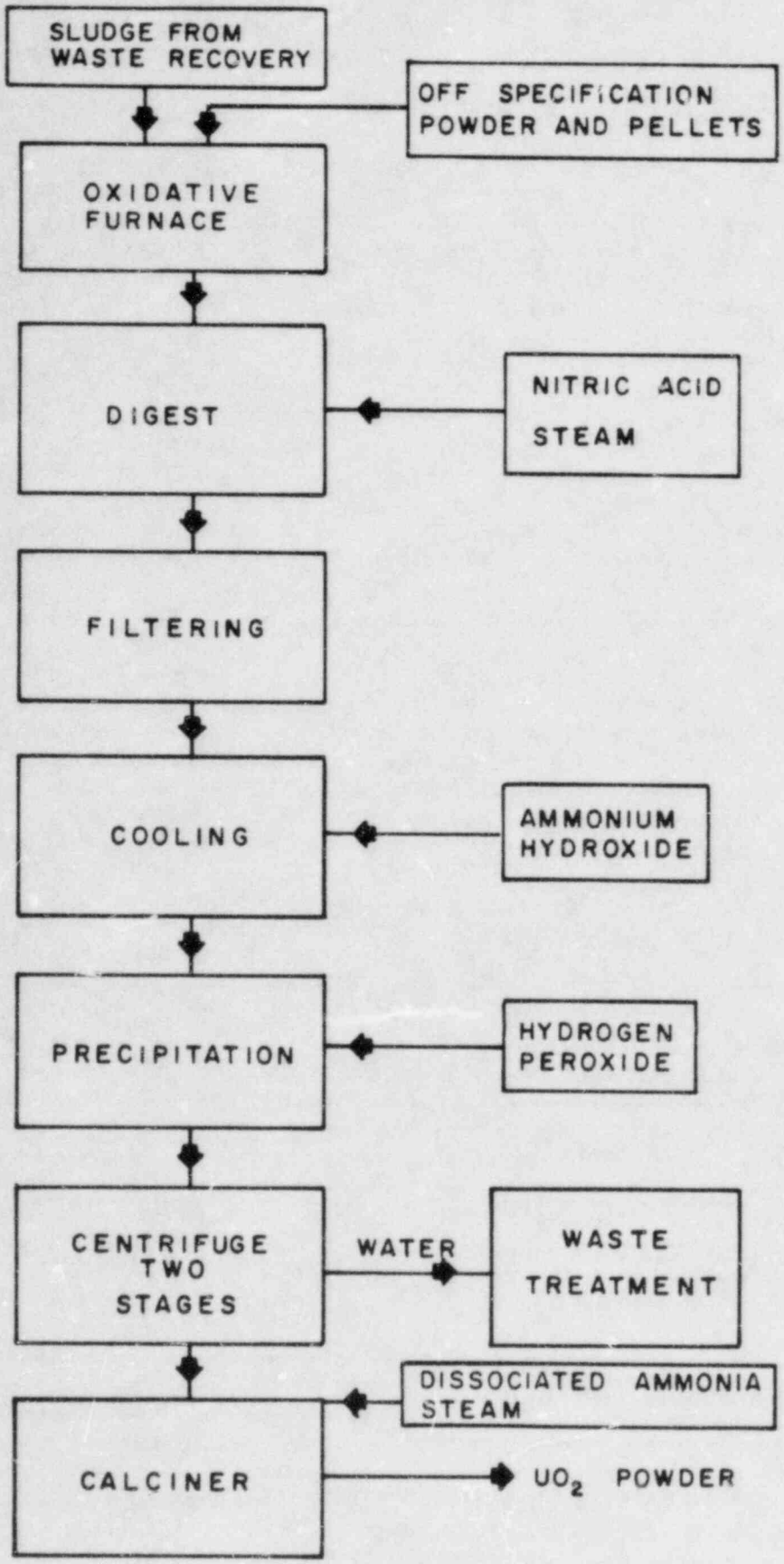


Figure 2.7 UPS process

2.2.1.6 Process Chemicals and Storage

Chemicals and gases used in fuel manufacturing, scrap recovery, waste processing, and non-fuel metal working are stored at various locations at the site. The locations of the storage facilities for each chemical or gas and the maximum quantities stored are shown in Figure 2.8.

2.2.2 Waste Confinement and Effluent Control

2.2.2.1 Gaseous emissions

Particulates are removed from the ventilation system servicing uranium process areas through the use of high efficiency particulate air (HEPA) filters. This filter type has a particle removal efficiency of 99.97% for 0.3 micron diameter particles. When the HEPA filters are loaded with particulates, as determined by measuring the pressure differential across the filter, they are removed and replaced. Exhaust systems that experience high particulate concentrations usually use more than one HEPA filter operated in series and/or roughing filters placed before the HEPA filters to reduce change-out rates.

Operations which could release uranium as mists or vapors are equipped with water scrubbing systems. The water sprayed into the ventilation air stream may contain chemicals to assist in the scrubbing action. The air stream from the scrubber is heated above the dewpoint and is passed through HEPA filters before being discharged to the environment. Water circulated in the scrubbers is routed to the uranium purification system or to the conversion process to recover the uranium scrubbed from the ventilation air stream.

A portion of the ventilation air in the Fuel Manufacturing Building is recirculated to conserve heating and cooling energy. The system is designed to ensure that the flow of air is from areas with low concentrations of uranium to areas expected to have higher concentrations and to ensure that air leakage is inward into the uranium processing areas from outside the building. There are currently 33 release vents at the GE facility where uranium can be exhausted to the atmosphere. These include points from the fuel manufacturing operations, waste treatment processes, solid waste incinerator, facility maintenance shop, and laundry. The release points are low vents rather than raised stacks. Each vent is equipped with a flow measuring device and a low-porosity filter paper sampler located downstream of all effluent control equipment. The filter paper sampler provides a continuous measure of uranium activity in the exhausted air. The filters are changed on a daily or weekly basis depending on the release point's past contribution to the total discharge. The radiological data collected for the years 1978-1982 are presented and discussed in Section 4.1.1.1.

The uranium fuel manufacturing process is also a source of airborne fluoride and nitrogen oxide ($NO_x$) emissions. GE reports that four discharge points from the chemical conversion operations and one point from the incinerator release fluorides in addition to uranium to the atmosphere. These exhaust systems are equipped with the same effluent control equipment as described above (i.e., scrubbers and/or HEPA filters) and are also equipped with a filter paper sampler for continuously measuring the fluoride emissions. The filters used for fluoride analyses are collected on a weekly basis and the results for 1978-1982 are presented in Section 4.1.1.1. The uranium purification system (UPS) produces

## PRIMARY CHEMICAL GAS STORAGE INFORMATION

| LOCATION | | CHEMICAL / GAS | STORAGE CAPACITY |
|---|---|---|---|
| EMO | | | |
| | 1 | Alkaline Cleaner | 660 Gal. |
| | 2 | Anhydrous Ammonia | 12,000 Gal. |
| | 3 | Nitrogen | 1,500 Gal. |
| | 4 | Chromic Acid | 900 lbs |
| | 5 | Propane | 500 lbs |
| | 6 | Argon | 1,500 Gal. |
| | 7 | Acetone | 550 Gal. |
| FCO | | | |
| | 8 | Tube Lubricant T631 | 1,200 Gal. |
| | 9 | Helium | 75,000 SCu.Ft. |
| | 10 | Argon | 1,500 Gal. |
| | 11 | Sodium Hydroxide | 7,500 Gal. |
| | 12 | Nitric Acid | 5,000 Gal. |
| | 13 | Hydrofluoric Acid | 5,000 Gal. |
| | 14 | Tube Lubricant 31S | 1,000 Gal. |
| | 15 | Coolant | 1,000 Gal. |
| | 16 | Acetone | 550 Gal. |
| SITE | | | |
| | 17 | Sulfuric Acid | 8,000 Gal. |
| | 18 | Chlorine Gas | 2,400 lbs |
| | 19 | Gasoline | 10,000 Gal. |
| | 20 | Lime | 120 Tons |
| FMO-FMO-X | | | |
| | 21 | Acetone | 550 Gal. |
| | 22 | Liquid Nitrogen | 10,000 Gal. |
| | 23 | Liquid Oxygen | 6,000 Gal. |
| | 24 | Nitric Acid | 6,000 Gal. |
| | 25 | Hydrogen Peroxide | 7,000 Gal. |
| | 26 | Anhydrous Ammonia | 24,000 Gal. |
| | 27 | Propane | 60,000 Gal. |
| | 28 | Aqueous Ammonia | 20,000 Gal. |
| | 29 | Hydrochloric Acid | 7,000 Gal. |
| | 30 | Sodium Hydroxide | 7,000 Gal. |
| | 31 | Hydrogen | 45,000 SCu.Ft. |
| | 32 | Helium | 225,000 SCu.Ft. |
| | 33 | Argon | 1,500 Gal. |
| | 34 | Liquid Nitrogen | 1,500 Gal. |
| | 35 | Hydrofluoric Acid | 8,000 Gal. |
| | 36 | Uranium Hexafluoride | 1,000,000 lbs. |

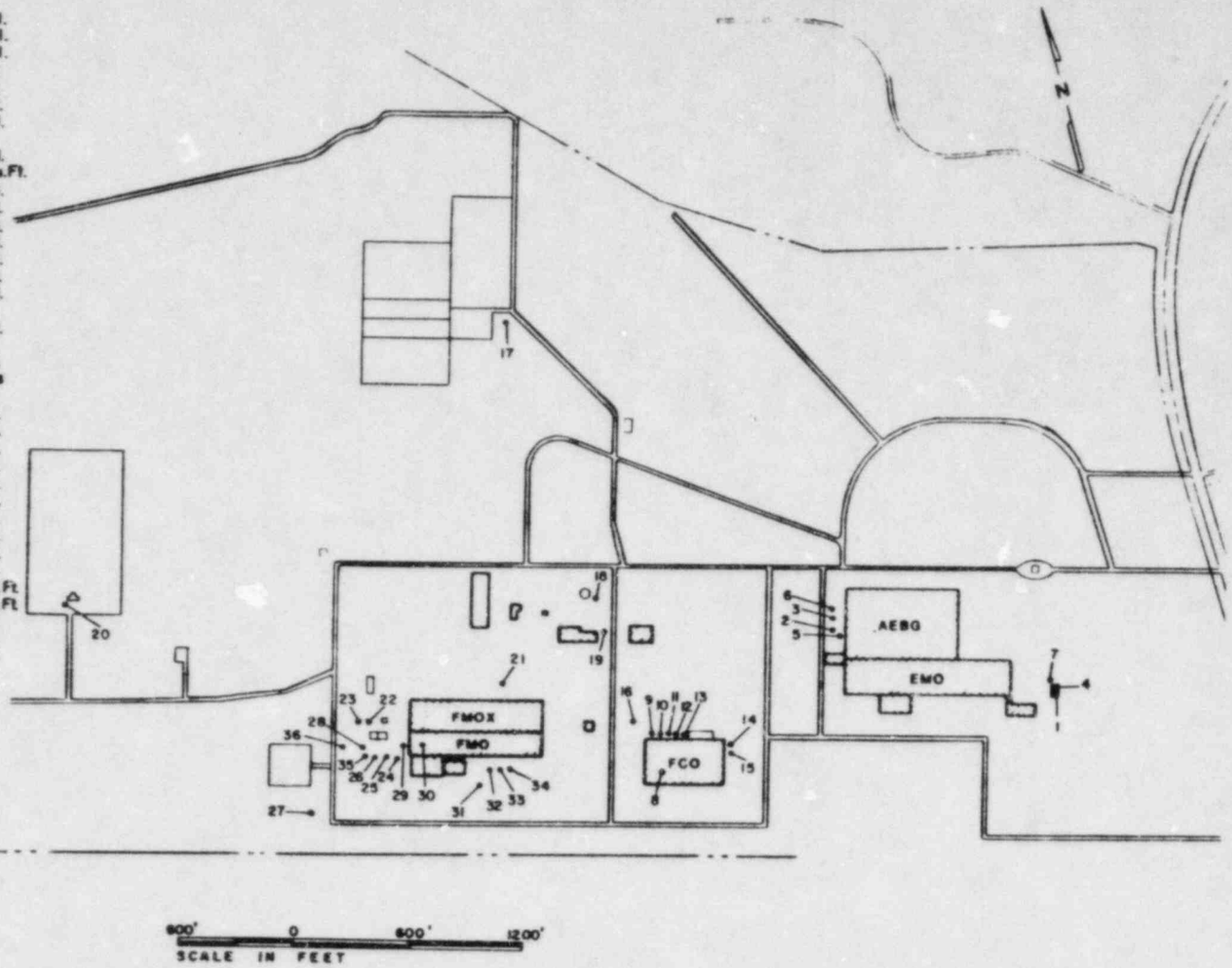


Figure 2.8 Process chemical and gas storage location and capacities

a gaseous effluent of $NO_x$ fumes. These gases are removed from the exhaust air by means of an absorber system in which oxygen is used to convert $NO_x$ to nitric acid which is reused in the process. The system efficiency is greater than 94% according to GE which results in minor quantities of $NO_x$ being released to the atmosphere.

Additional quantities of fluoride, as well as other nonradiological constituents, are released from other GE operations that do not involve handling of uranium. These operations are primarily associated with cleaning of non-fuel metalic components. For example, fluorides are released from the Fuel Components Operations and from the Aircraft Engine Manufacturing Operation (see Figure 2.3 for the location of these buildings). Ammonia is discharged to the atmosphere from a steel nitriding process in the Equipment Manufacturing Operation. As with any manufacturing facility, there are a variety of other nonradiological air emissions and several of the processing areas have special ventilation requirements to control their discharge to the atmosphere. Nonradiological gaseous effluents from many of GE's operations are discharged in accordance with requirements of permits issued by the State of North Carolina.

2.2.2.2 Liquid Effluents

GE's liquid effluent systems are designed to handle and segregate industrial process wastes, sanitary wastes, and storm waters. These wastes are collected and treated in a variety of processes as described below.

A. Process Liquid Wastes

The process liquid effluent sources and treatment steps are outlined in Figure 2.9. The process liquid wastes that may contain uranium originate solely from the Fuel Manufacturing Building and they are separated into fluoride, nitrate, and low-level radioactive wastes depending on their chemical constituents.

Fluoride Waste

The liquid waste streams removed from the centrifuges in the ADU wet conversion process and scrubber solution from the defluorinator-calciner used in the GECO process are classified as fluoride wastes. The liquids are collected in quarantine tanks and each batch is analyzed for uranium concentration. Batches containing recoverable concentrations of uranium are recycled, and the remaining batches are transferred to a surge storage tank. Periodically, the fluoride waste is pumped via an above-ground pipeline to a settling tank in the waste treatment facility (see Figure 2.3). The sludge from the conical bottom of this tank is removed and returned for recovery of the uranium by an offsite vendor and then returned to the process through the UPS.

At the waste treatment facility, the liquid is treated by adding lime ($Ca(OH)_2$) to raise the pH which causes the fluoride to be precipitated as $CaF_2$. The ammonia in the solution is recovered as ammonium hydroxide and returned to the process. The $CaF_2$ slurry is discharged to two fluoride storage lagoons in the waste treatment facility where the $CaF_2$ settles to the bottom as sludge. The lagoons are equipped with a single elastomer lining and, as is the case for all liquid waste treatment lagoons at the Wilmington plant, are permitted through

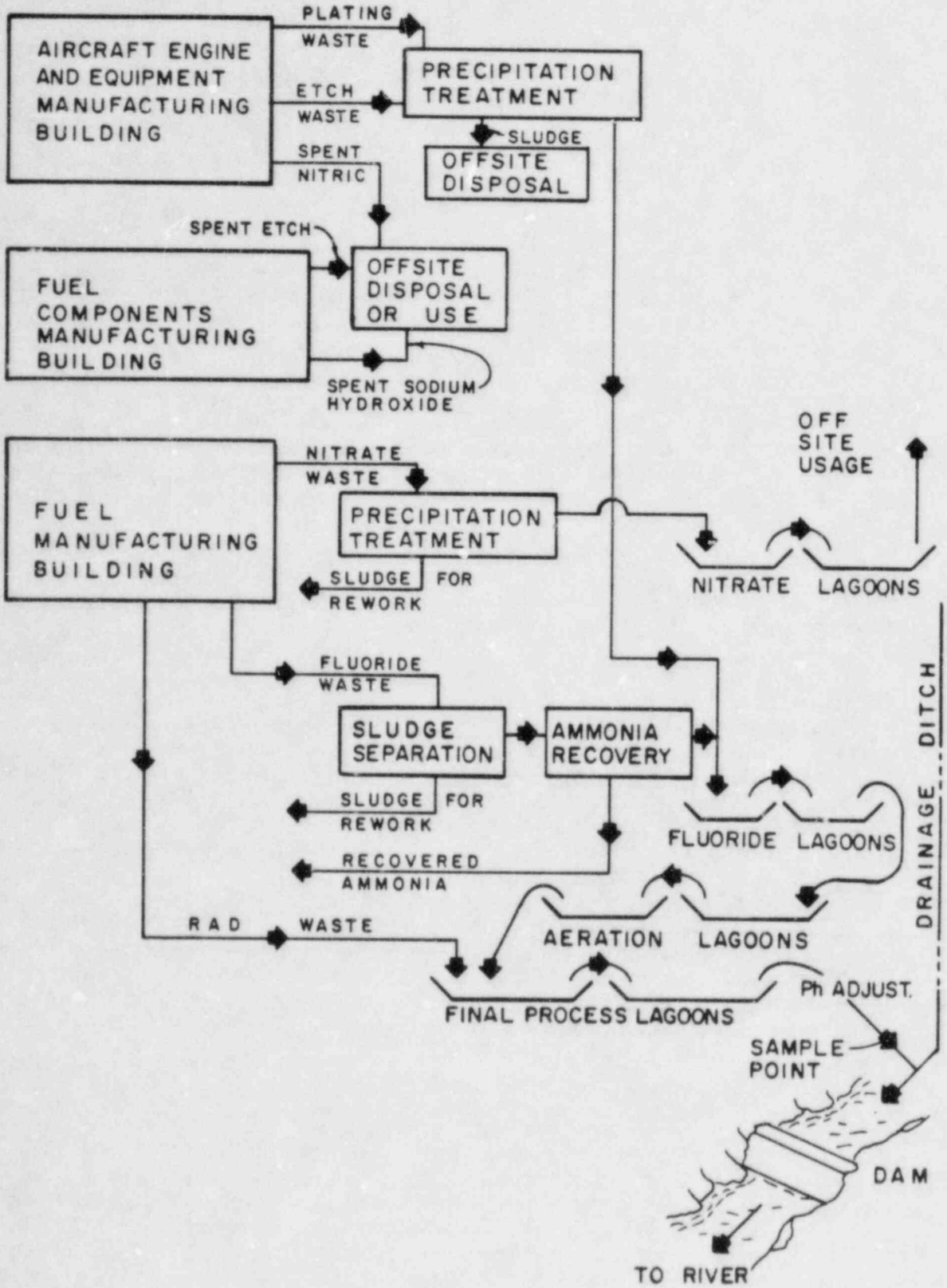


Figure 2.9 Process liquid effluent sources and treatment steps

North Carolina's Department of Natural Resources and Community Development. In the past, the $CaF_2$ sludge has accumulated on the lagoon bottoms, but GE is developing a process through which the sludge is to be treated and disposed (Section 2.2.2.3). The effluent from the fluoride lagoons is transferred to the Final Process Lagoon area north of the Fuel Manufacturing Building (Figure 2.3). The liquid waste is piped above ground for part of this transfer, but at one point the pipelines turn under ground.

At the final process lagoon area, the fluoride waste is initially held in an "aeration basin" for settling and then it is transferred to two final process lagoons where lime is added and precipitation and final settling occur. The aeration basin and final process lagoons have packed clay liners. About once every 3 years, the $CaF_2$ sludge that accumulates in these lagoons is dredged and stored onsite (Section 2.2.2.3). The liquid portion is pH adjusted by the addition of sulfuric acid ($H_2SO_4$) and is released to a drainage ditch. The final effluent is sampled before being discharged and its quality is controlled by a State-issued NPDES permit and by the NRC. Recent monitoring data from the final process lagoon outfall are presented in Section 4.1.1.2. The drainage ditch, which is a natural creek enlarged and expanded by GE during site development, is all on GE's property (about 2.2 miles long) and eventually outfalls into the Northeast Cape Fear River. About 2,000 feet from the lagoon outfall, a dam is located in the ditch which is used to impound liquid effluent for additional treatment, if necessary, or to monitor releases to protect the receiving river.

Nitrate Waste

Liquid waste streams containing ammonium nitrate are generated in the UPS process areas. These wastes are quarantined, analyzed for uranium content, and eventually transferred by above-ground pipeline to the waste treatment facility. Lime is added to precipitate calcium uranate. The uranium precipitate is then returned to fuel manufacturing for recovery, and the liquid waste is discharged to nitrate storage basins in the waste treatment area. The nitrate lagoons are equipped with a single elastomer lining. Solids settle to the bottom of these lagoons and the liquid portion, if it contains a uranium concentration below that specified in the license, is transported by truck to a local paper manufacturer (in accordance with GE's license). The nitrate solution is used in the nutrient system for a biological waste treatment facility owned by the paper company. After utilized in this waste treatment system, the solution is ultimately discharged to the Cape Fear River.

Low-Level Radioactive Wastes

Low-level radioactive liquid wastes are collected from laboratory sinks, floor washings, equipment decontamination operations, protective clothing laundry, and similar fuel building surfaces. These wastes are centrifuged to remove solids which are returned to the UPS for uranium recovery. The clarified liquors are recycled if necessary and routed directly to the aeration basin in the final process lagoon area where it is mixed with the liquid fluoride wastes. It is then treated with the fluoride waste and discharged to the site drainage ditch and then to the Northeast Cape Fear River.

Other Process Liquid Wastes

Another uranium-bearing liquid waste produced from GE's fuel manufacturing operation is a hydrofluoric acid solution generated in the GECO conversion process. Hydrofluoric acid is collected in a bulk storage tank and sampled for its uranium content. Material containing less than 3 ppm of uranium is currently shipped offsite in accordance with the license for beneficial uses. The solution is transferred to a recipient specified by the license whose uses of it are such that the uranium will not enter into any food, beverage, cosmetic, drug or other commodity designed for ingestion or inhalation by, or application to, a human being. Additionally, the acid in used in a process which will not release radioactivity to the atmosphere as airborne material and whose residues will remain in a lagoon system.

As shown in Figure 2.9, several nonradiological process liquid wastes are produced from other GE operations not associated with uranium processing. Liquid plating wastes and etch solutions are generated by operations in the Aircraft Engine and Equipment Manufacturing Building. Because of the corrosive and toxic nature of these wastes, they are defined as hazardous by EPA regulations (40 CFR Part 261). Accordingly, GE's handling of these wastes is being controlled by the EPA and the State Department of Environmental Health through permits under the Resource Conservation and Recovery Act. The plating waste and etch solutions are treated onsite to remove the metal impurities. The metals are precipitated into a sludge which is transported to an approved chemical waste landfill. The supernatant liquid, after sampling and analysis, is transferred to the fluoride lagoons in the waste treatment facility. There it is mixed with the liquid fluoride waste and is treated and discharged as described above. Spent nitric acid and nitric-hydrofluoric acid mixtures are collected from the metal etching operations in the Aircraft Engine, Equipment, and Fuel Components Manufacturing Buildings. These wastes are also classified as hazardous and are disposed of offsite via an EPA approved deep well injection facility. Spent sodium hydroxide is transported as a feed stock chemical to an offsite manufacturer and used.

B. Sanitary Wastes

Sanitary wastes are collected separately from the process wastes and routed to an onsite extended aeration treatment facility which includes sludge settling and recycle. Effluent from the sanitary waste treatment system is combined with liquid process wastes and storm waters in the site drainage ditch and eventually outfalls into the Northeast Cape Fear River.

C. Storm Waters

During site development, the plant area was graded to direct storm water runoff to several small ditches around the site which all feed into the main site drainage ditch shown in Figure 2.3. Storm waters are mixed with treated process liquid wastes and sanitary effluents in this ditch and discharged to the Northeast Cape Fear River. The dam in the drainage ditch can be utilized to contain runoff from the developed areas, if necessary.

2.2.2.3 Solid Wastes

Solid wastes are collected for disposal throughout the plant. The wastes are classified as uranium-contaminated or contamination-free. Each of these classifications is further subdivided into combustible or noncombustible categories. Solid wastes known to be contaminated are collected at the point of origin and processed as described in the following subsections. Wastes suspected to be contaminated are collected and assayed for uranium content. If the wastes are found to be free of contamination, they are treated and disposed of in a variety of ways briefly described below.

A. Noncombustible Contaminated Waste

Noncombustible contaminated waste includes segments of process piping, ventilation ducting, pumps, motors, valves, and HEPA and other filters from the air cleaning system. After employing practical chemical or mechanical recovery methods, the solid wastes are collected into specially designed boxes, assayed, and shipped offsite (presently to Barnwell, South Carolina) for ultimate disposal at a Government-licensed waste burial site.

A variety of noncombustible uranium-bearing sludges is stored onsite. The first is a calcium fluoride ($CaF_2$) sludge generated from the fluoride waste stream. GE estimates that there is approximately $1.8 \times 10^6$ $ft^3$ of this sludge presently stored onsite containing approximately 1500-2000 ppm uranium. Long-term disposal of sludge with this uranium content at other than a licensed disposal site is not currently permitted under existing standards,[5] so it is held pending further processing for uranium recovery. The sludge is stored in either the fluoride lagoons at the waste treatment facility, $CaF_2$ storage pits in the final process lagoon area, or in trenches and on the land surface at a storage ground in the far northwest corner of the site. GE has initiated a program for advanced waste treatment of the contaminated process liquid wastes. This program, called the Uranium Process Management Project (UPMP), is designed to, among other things, recover uranium from GE's process wastes prior to their release to the waste treatment facility and subsequent lagoon systems. The UPMP is consequently intended to reduce the uranium content of newly produced $CaF_2$ sludge to levels acceptable for burial and thereby decrease the accumulation of contaminated sludge during routine operation in the future. GE has received NRC approval for the construction phase of UPMP and a request for approval of its operational phase is pending. For the large quantity of $CaF_2$ already on site, GE is investigating a capability to recover the uranium content rendering the sludge acceptable for burial. By doing this, the Uranium Recovery Lagoon Sludge (URLS) Project is designed to reduce the present $CaF_2$ inventory and the environmental impact of the waste treatment lagoon system. The NRC has approved the construction of a pilot plant to develop this capability.

In treating the liquid nitrate wastes, a uranium-bearing sludge settles in the nitrate lagoons at the waste treatment facility. At present, this sludge is retained in these lined lagoons.

Deposits of contaminated zirconium sludge were stored immediately southwest of the waste treatment facility from 1976 to 1982 (see Figure 3.2 for location of former zirconium sludge storage area). The sludge was formed by precipitating

impurities in a solution used for chemical etching of zirconium. The resulting precipitate was contaminated with uranium after being accumulated in lined lagoons which had been previously used to treat other chemical wastes from the fuel manufacturing operation. The sludge contained about 0.8 picocurie per gram uranium and consisted of roughly 10% calcium nitrate and 20% calcium fluoride among other materials. Despite efforts to prevent the movement of these wastes into the groundwater, monitoring wells located downgradient of the storage area showed that some contaminants, particularly the nitrates, were migrating. Nitrates in adjacent monitoring wells rose to as high as 5200 ppm. As a result, the sludge was removed in 1982 and disposed of at a hazardous waste disposal site in Pinewood, South Carolina. Following the excavation activities required to remove the sludge, the underlying soil left in place was surveyed by GE and found to contain uranium concentrations typical for background.[6] Recent groundwater monitoring results from around the former zirconium sludge storage area are presented in Section 4.1.2.3.

B. Combustible Contaminated Waste

Combustible contaminated waste, including such items as rags, mops, paper, plastic, and worn out protective clothing, are decontaminated as much as practical and packaged in wooden boxes. The wastes are then burned in an onsite incinerator. An ash is produced by this process and its method of disposal depends on uranium content. The ash is either buried at an NRC-approved site or reprocessed offsite at an approved facility for uranium recovery. The recovered uranium, in the form of uranal nitrate, is returned to the Wilmington plant for further reprocessing in the UPS.

C. Noncontaminated Wastes

Several noncontaminated solid wastes are produced from GE's operations. As previously mentioned in Section 2.2.2.2, plating waste sludges are transported to an RCRA-approved chemical landfill. Solid wastes that are combustible, such as oils, certain spent solvents, and coolant and dye concentrates, are incinerated either at GE or at an offsite location. Other noncontaminated solid wastes are beneficially used. These include scrap metal, spent caustics, and wood.

## 2.3 Decommissioning

All major material licensees are required to submit a general decommissioning plan to be effected at the end of plant life. This plan describes how the facilities and grounds will be decontaminated so that they can be released for unrestricted use. The plan identifies and discusses the major factors that influence the cost of decontaminating the facilities and grounds and provides a cost estimate for these activities. The decommissioning plan and a corporate commitment to provide funds for this effort are incorporated as conditions of the license. On December 11, 1981, such conditions were incorporated into GE's License No. SNM-1097.

## 2.4 Nuclear Material Safeguards

Current safeguards are set forth in 10 CFR Parts 70 and 73. The regulations in Part 70 provide for material accounting and control requirements with respect

to facility organization, material control arrangements, accountability measurements, statistical controls, inventory methods, shipping and receiving procedures, material storage practices, records and reports, and management control.

The Commission's current regulations in 10 CFR 73 provide requirements for the physical security and protection of fixed sites and for nuclear materail in transit. Physical protection requirements for special nuclear materail of low strategic significance (including low-enriched uranium) include provision for establishment of controlled access areas, monitoring of these areas to detect unauthorized penetration, provision of a response capability for unauthorized penetrations and activities, and establishment of procedures for threats of theft and for actual thefts.

The Commission's regulations in 10 CFR Parts 70 and 73, described briefly above, are applied in the reviews of individaul license applications. License conditions then are developed and imposed which translate the regulations into specific rquirements and limitations that are tailored to fit the particular type of plant or facility involved.

The licensee has an approved material control and accounting plan and an approved physical security plan which meet the current requirements for the low-enriched uranium which would be possessed at the site. It is concluded, therefore, that the safeguards-related environmental impact of the proposed action is insignificant.

## 2.5 Staff Evaluation of the Proposed Action and Alternatives

The staff believes that the fuel manufacturing operations at the GE facility are performed in a manner that protects both the public and the environment from unusual or adverse impact; however, as discussed in the indicated sections, the staff recommends addition of the following requirements:

a. GE will be required to sample possible forage vegetation onsite and analyze for fluoride on a semiannual basis (Sects. 4.1.1.1(B), 4.1.2.1(B), and 4.1.3).

b. GE will be required to notify the NRC Regional Administrator within 10 days of any violation of the NPDES permit (Sects. 4.1.1.2(B) and 4.1.3).

c. GE will be required to take samples and perform uranium analyses of bottom sediments from at least three locations in the liquid effluent drainage ditch (Sects. 4.1.2.4 and 4.1.3).

d. GE will be required to take samples from individual supply well numbers 9, 11, and 14 on a monthly basis and analyze for gross alpha and gross beta concentrations (Sects. 4.1.2.3(E) and 4.1.3).

e. If any shallow monitoring well specified for periodic monitoring under the license is found to be dry for extended periods, GE will be required to take appropriate steps to reposition the well so that a water sample of the upper aquifer can be obtained. Any changes made to a well can not

decrease the effectiveness of the overall groundwater monitoring program (Sects. 4.1.2.3 and 4.1.3).

f. GE will be required to not move a cylinder containing liquid $UF_6$ with the exception of cylinders containing only residual quantities left after vaporization (Sects. 4.3.1.2(A) and 4.1.3).

The environmental impact of continued operation is expected to be insignificant providing that these requirements are added to the license.

# 3. THE AFFECTED ENVIRONMENT

## 3.1 Site Description

The GE plant site is located in New Hanover County in Southeastern North Carolina (Figures 2.1 and 2.2). New Hanover County is in the coastal plain region with the Atlantic Ocean approximately 10 miles east of the GE plant. The plant site and surrounding areas are typically flat, swampy, and low-lying (the average elevation is less than 40 feet above mean sea level). The Northeast Cape Fear River, an estuarine branch of the Cape Fear River system, forms the southwesterly boundary of the plant site. Forest lands border the site to the north and border much of the south property line; however, there are some residential areas south of GE's property. U.S. Highway 117 forms the east border of the GE site except for approximately 12 acres across the highway used for employee parking and recreation. Plant buildings and structures are located over 1,000 feet from this highway and there is little evidence of industrial activity from the road. Because of landscaping during site development and a continued maintenance of the grounds, the plant now appears compatible with the surroundings.

## 3.2 Land

### 3.2.1 Site Area

The plant site occupies a total area of 1664 acres. The developed portion of the site including manufacturing buildings and support facilities, paved areas, waste treatment facilities and lagoons, and other landscaped areas consist of about 338 acres, representing approximately 20% of the total site area. All of these developed areas are located on the eastern half of GE's property well above the 100- and 500-year floodplain.[3] The Northeast Cape Fear River is tidal and the highest tide recorded in the Wilmington area was 10 feet above normal during Hurricane Ione in 1955. The plant facilities are located 30-35 feet above mean high tide and, as such, would not be flooded by a tide equivalent to the historical high.

Before the plant was constructed, the site had been used for lumbering and farming and much of the land was stripped of trees. A large portion of the undeveloped site area has been replanted with more than 20,000 trees and now approximately 975 acres of the GE site is forested mostly with pines. Another 182 acres in the southwest section is classified as swamp forest. The remainder of GE's undeveloped land is a combination of fields, borrow pits, power supply lines, unpaved roads, and a railroad right-of-way.

### 3.2.2 Adjacent Area

The area surrounding the GE plant is mostly timbered and agricultural; however, there are several light commercial establishments and single-family dwellings interspersed throughout the area. A small shopping center is located about 3 miles south of GE on U.S. Highway 117. A few churches, three schools, one county prison, and three other manufacturing plants (for the production of

ammonium nitrate fertilizer, chemical intermediates, and pile fabrics) are within 5 miles of the GE site. Castle Hayne is the nearest community and it is located 3 miles northeast of the plant. The property immediately north has limited residential development, but the property immediately south is lightly residential. The nearest residence to the plant is a single family house located approximately 1,800 feet south-southeast of the fuel manufacturing building.

### 3.2.3 Historic Significance

A gravesite is located on the plant property and at one time (probably in the mid-1800's) a rice plantation may have also existed on the GE site. GE has permitted archaeological investigations on the site and has provided visitation rights to the gravesite. The archaeologically sensitive areas of GE's property were not disturbed during plant construction and future activities are not expected to encroach on the areas. The city of Wilmington, approximately 6 miles south of the GE site, has a rich historical background and an active effort is in progress in downtown Wilmington to restore and rebuild its Historic District. There are currently five historic sites in Wilmington that are listed on the National Register of Historic Places.[7] The closest natural feature listed on the National Registry of Natural Landmarks is about 25 miles southwest of GE (the Green Swamp located 9 miles north of Supply, North Carolina).[8] Because of the distance from GE to these nearest historic and natural sites, operation of the GE facility should not affect their use.

## 3.3 Regional Demography and Socioeconomic Profile

The area within a 50-mile radius of the plant site encompasses all or part of eight counties in North Carolina and a small section of northeastern South Carolina. The area also extends into the Atlantic Ocean (Figure 3.1).

The eastern portion of North Carolina is generally rural with small towns and villages interspersed among the farm regions. The cities of Wilmington in New Hanover County, Clinton in Samson County, and Midway Park in Onslow County are the only community centers with populations of more than 10,000 within 50 miles of the plant. According to 1980 census data, the City of Wilmington has a population of 44,000 and Castle Hayne, the community closest to the plant (3 miles northeast), has a population of 1,087. Only three incorporated population centers within 20 miles of GE have permanent populations larger than 1,000 (they are Burgaw, Wrightsville Beach, and Carolina Beach). The 1980 incremental and cumulative population distribution by distance and direction from the plant is given in Tables 3.1 and 3.2, respectively. The population within 5 miles of the GE plant is about 11,000 and the total population of the area out to 50 miles from the plant is about 370,000.

During the period from 1970 to 1980, the population in New Hanover County has grown by roughly 25%. The surrounding counties shown in Figure 3.1 have experienced similar population increases. New Hanover County has also become increasingly urban over this 10-year period (87% urban in 1980 opposed to 70% in 1970). According to projections of the Wilmington-New Hanover Planning Department, New Hanover County is expected to grow by another 26,000 residents (another 25%) by 1990.[9] The City of Wilmington population has decreased since 1970; however, revitalization efforts are expected to reverse this trend during

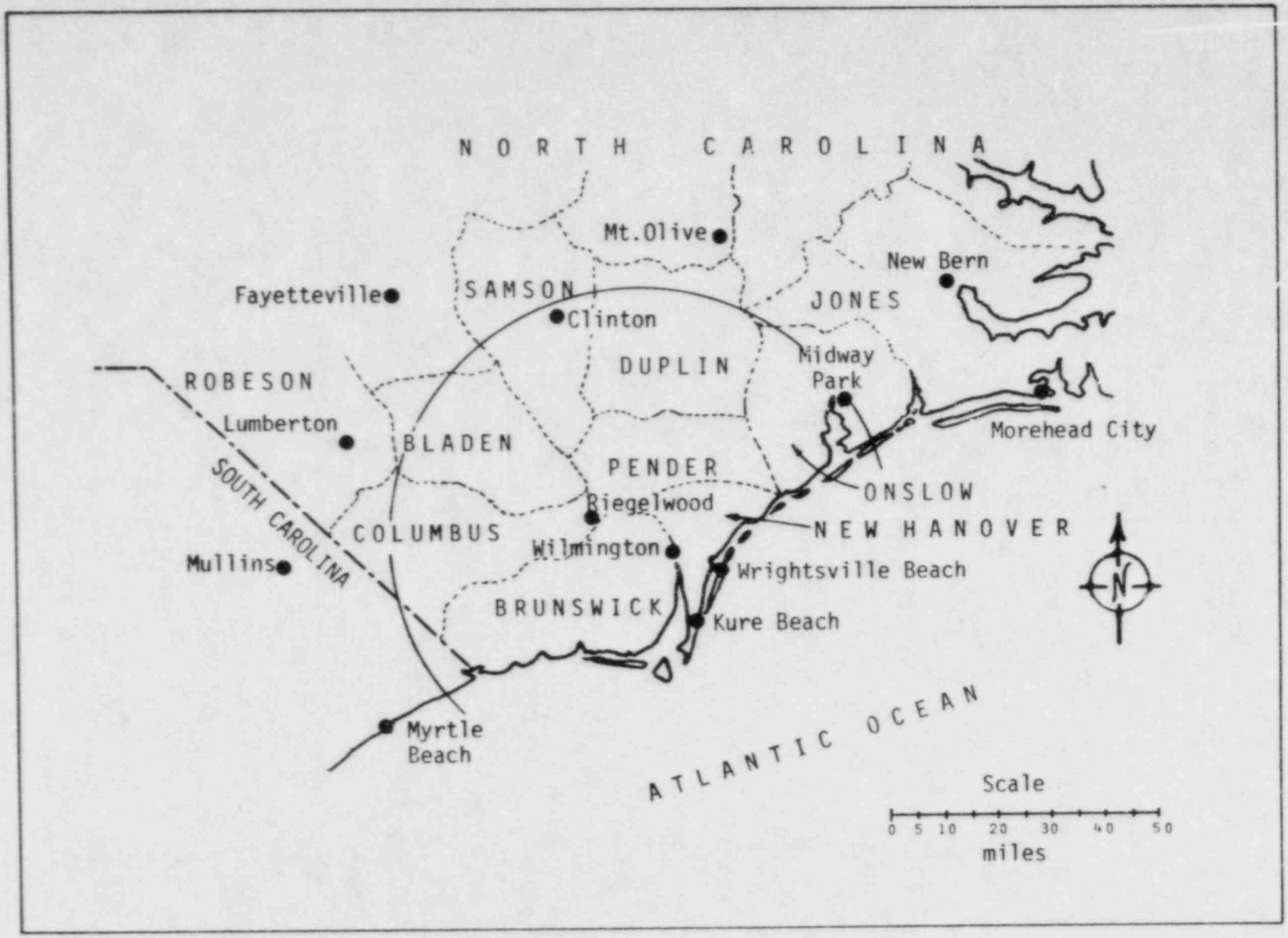


**Figure 3.1 Population centers in 50-mile radius of GE plant**

Table 3.1 Incremental 1980 population data within 50 miles of the GE plant by distances and directions

| Direction | Distance (Miles) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0-1 | 1-2 | 2-3 | 3-4 | 4-5 | 5-10 | 10-20 | 20-30 | 30-40 | 40-50 |
| N | 34 | 79 | 82 | 83 | 67 | 527 | 3,971 | 6,483 | 7,401 | 9,307 |
| NNE | 31 | 51 | 67 | 73 | 44 | 406 | 1,441 | 1,046 | 5,642 | 9,651 |
| NE | 26 | 45 | 52 | 75 | 69 | 359 | 548 | 2,072 | 16,838 | 70,343 |
| ENE | 18 | 40 | 43 | 60 | 73 | 452 | 2,105 | 1,216 | 2,455 | 3,130 |
| E | 23 | 40 | 51 | 63 | 111 | 1,713 | 208 | 0 | 0 | 0 |
| ESE | 18 | 25 | 66 | 147 | 219 | 3,857 | 0 | 0 | 0 | 0 |
| SE | 24 | 15 | 35 | 180 | 136 | 7,728 | 2,445 | 0 | 0 | 0 |
| SSE | 32 | 23 | 108 | 438 | 718 | 24,223 | 3,553 | 0 | 0 | 0 |
| S | 36 | 108 | 502 | 462 | 1,429 | 43,981 | 6,120 | 2,471 | 0 | 0 |
| SSW | 38 | 123 | 152 | 16 | 669 | 318 | 1,936 | 4,437 | 724 | 0 |
| SW | 37 | 115 | 170 | 108 | 321 | 2,699 | 3,326 | 2,046 | 7,074 | 3,820 |
| WSW | 37 | 110 | 159 | 174 | 203 | 1,633 | 818 | 1,921 | 2,457 | 6,141 |
| W | 37 | 110 | 162 | 175 | 177 | 595 | 2,328 | 2,235 | 4,759 | 18,274 |
| WNW | 37 | 110 | 167 | 166 | 141 | 708 | 724 | 2,524 | 3,312 | 11,960 |
| NW | 36 | 108 | 164 | 169 | 138 | 774 | 1,430 | 2,368 | 2,850 | 2,912 |
| NNW | 35 | 104 | 123 | 111 | 114 | 648 | 1,857 | 2,927 | 3,864 | 7,087 |
| TOTAL | 499 | 1,206 | 2,103 | 2,500 | 4,629 | 90,621 | 32,810 | 31,746 | 57,376 | 142,625 |

Table 3.2. Cumulative 1980 population data within 50 miles of the GE plant by distances and directions

| Direction | Distance (Miles) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0-1 | 0-2 | 0-3 | 0-4 | 0-5 | 0-10 | 0-20 | 0-30 | 0-40 | 0-50 |
| N | 34 | 113 | 195 | 278 | 345 | 872 | 4,644 | 11,127 | 18,528 | 27,835 |
| NNE | 31 | 82 | 149 | 222 | 266 | 672 | 2,150 | 3,196 | 8,838 | 18,489 |
| NE | 26 | 71 | 123 | 198 | 267 | 626 | 1,224 | 3,296 | 20,134 | 90,477 |
| ENE | 18 | 58 | 101 | 161 | 234 | 686 | 2,713 | 3,929 | 6,384 | 9,514 |
| E | 23 | 63 | 114 | 177 | 288 | 2,001 | 2,035 | 2,035 | 2,035 | 2,035 |
| ESE | 18 | 43 | 109 | 256 | 475 | 4,332 | 4,332 | 4,332 | 4,332 | 4,332 |
| SE | 24 | 39 | 74 | 254 | 390 | 8,118 | 10,563 | 10,563 | 10,563 | 10,563 |
| SSE | 32 | 55 | 163 | 601 | 1,319 | 25,542 | 29,095 | 29,095 | 29,095 | 29,095 |
| S | 36 | 144 | 646 | 1,108 | 2,537 | 46,518 | 48,287 | 50,758 | 50,758 | 50,758 |
| SSW | 38 | 161 | 313 | 329 | 998 | 1,316 | 8,570 | 13,007 | 13,731 | 13,731 |
| SW | 37 | 152 | 322 | 430 | 751 | 3,450 | 6,591 | 8,637 | 15,711 | 19,531 |
| WSW | 37 | 147 | 306 | 480 | 683 | 2,316 | 2,607 | 4,528 | 6,985 | 13,126 |
| W | 37 | 147 | 309 | 484 | 661 | 1,256 | 3,533 | 5,768 | 10,527 | 28,801 |
| WNW | 37 | 147 | 314 | 480 | 621 | 1,329 | 1,817 | 4,341 | 7,653 | 19,613 |
| NW | 36 | 144 | 308 | 477 | 615 | 1,389 | 2,703 | 5,071 | 7,921 | 10,833 |
| NNW | 35 | 139 | 262 | 373 | 487 | 1,135 | 2,646 | 5,573 | 9,437 | 16,524 |
| TOTAL | 499 | 1,705 | 3,808 | 6,308 | 10,937 | 101,558 | 127,463 | 159,209 | 216,585 | 365,257 |

the 1980's. Approximately 2,250 persons are employed at the GE plant GE projects that this employment level will decrease slightly in the next few years. The population growth in the vicinity of the plant is not expected to be influenced by the continued operation of the plant.

## 3.4 Geology and Seismicity

### 3.4.1 Geology

The GE site is located in the Coastal Plain Region of North Carolina. This region is underlain by several layers of sedimentary rocks that generally dip toward the coast at a rate of 15 feet/mile.[10] The bedrock in the New Hanover County area is about 1,100-1,500 feet deep. The deepest sedimentary layer that contains fresh water is the Peedee Formation which consists of unconsolidated greenish-gray silt and sand along with black clay, consolidated calcareous sandstone and limestone. The Castle Hayne Formation overlies the Peedee and consists of shelly and siliceous limestone, sandy shell conglomerate, and shell beds. The Castle Hayne Formation is a productive limestone aquifer referred to as the principal aquifer (as opposed to the water table aquifer). Overlying the Castle Hayne are beach deposits, fossile sand dunes, and stream channel deposits consisting of sands and clays. Soils on the eastern (developed) portion of GE's site are a moderately well-drained conglomerate of fine sandy loam on the surface and sandy clay loam subsoil. The western area of the property near the Northeast Cape Fear River consists of a poorly-drained organic muck mixed with a sandy loam.

### 3.4.2 Seismicity

The southeastern portion of North Carolina is a relatively quiet seismic region. Nine events have been reported within 50 miles of the GE site. The plant is located in a Zone 1 area which corresponds to earthquake intensities of V to VI on the Modified Mercalli scale. The largest events were of intensity V in 1884 and 1958 and intensity IV to VI in 1886. The site buildings have been designed to withstand earthquakes with an intensity typical of those occurring in Zone 1 without incurring substantial structural damage.

## 3.5 Hydrology

### 3.5.1 Surface Water

The Northeast Cape Fear River receives most of the storm water runoff and all of the liquid waste discharges from the GE plant. The Northeast Cape Fear River is approximately 125 miles long and, in the vicinity of the GE site, roughly 250 feet wide. It has an average gradient of 0.27 feet/mile and a total drainage area of approximately 1,740 square miles. About 7 miles south of the plant site, the Northeast Cape Fear River joins the Cape Fear River which widens into an estuary discharging to the Atlantic Ocean about 20 miles further south.

The flow patterns of the Northeast Cape Fear River reflect its estuarine characteristics. In areas around GE, the river experiences diurnal tides with a tidal range of 1 to 5 feet. The water is brackish and the fresh water flow rate is much lower than the overall river flow rate. The U.S. Geological Survey determined that the volume of water passing the site during a particular

ebb and flood tidal cycle is 220 million cubic feet and 310 million cubic feet, respectively, while the fresh water inflow was estimated at only 11 million cubic feet during the same period. The river's average fresh water flow rate exceeds 1,000 $ft^3$/sec and the 10-year, 7-day low flow value representing the fresh water flow rate past the plant is about 15 $ft^3$/sec.

Preoperational data (1968) provided by GE show the river to be generally acidic with a pH of 6.7 to 6.9. Low concentrations of ammonia, nitrate, fluoride, and metals (chromium, copper, and nickel) are naturally present. The North Carolina Department of Natural Resources and Community Development has designated the river best suited for fishing and any other usage except bathing or shellfishing for market purposes. GE reports that there are no communities or individuals downstream of the site that are known to use the river for a fresh water supply. The City of Wilmington obtains its potable water supply from the Cape Fear River approximately 20 miles above its confluence with the Northeast Cape Fear River.

### 3.5.2 Groundwater

Groundwater at the GE site occurs in a shallow sand aquifer under water table conditions and in a semiconfined principal aquifer (Section 3.4.1). These groundwater units are generally separated from each other by a silty-clayey layer approximately 10-15 feet below land surface; however, the continuity of this confining layer is uncertain. The shallow aquifer is not used by GE, but it does provide yields sufficient for domestic use and small irrigation supplies in surrounding areas. Water is withdrawn from the principal aquifer for GE's drinking and process water supplies (Section 2.2.1.5) and the aquifer is a productive source of fresh water for residential, commercial, and other industrial facilities in the area. Preoperational (1968) chemical characteristics of groundwater from the principal aquifer are presented in Table 3.3.

Groundwater contours in the shallow aquifer under the GE site are shown in Figure 3.2. The water table is near land surface and recharge occurs directly by rainfall. The flow pattern of shallow groundwater according to Figure 3.2 is from both the north and south towards the main site drainage ditch used to carry liquid effluents to the Northeast Cape Fear River. Shallow groundwater does not flow offsite from GE's developed areas. The ditch is approximately 10 feet deep and, depending on the continuity of the confining layer, shallow groundwater either discharges into the ditch or into the underlying principal aquifer. The ditch itself may penetrate the clay confining layer in some areas. Therefore, once in the ditch, some water and liquid waste may percolate into the principal aquifer instead of flowing as surface water into the river. While such waste migration is possible, contamination of the principal aquifer downgradient of the drainage ditch has not been observed (Section 4.1.2.3).

A map of the potentiometric surface of the principal aquifer under the GE site is shown in Figure 3.3. Geohydrological investigations by GE indicate that recharge of the principal aquifer mainly occurs 6 miles southeast of the site. General groundwater flow for the region is to the north and west from this recharge area toward the Northeast Cape Fear River which serves as a discharge zone. At the GE site, however, groundwater flow in the principal aquifer is essentially toward the center of a large cone of depression created by the plant supply wells. It is expected that groundwater flow in adjacent offsite areas is also generally toward this cone of depression and toward GE's property.

The flow velocity in the principal aquifer is about 300 feet/year with possibly greater flow rates near the cone of depression.

Table 3.3 Preoperational chemical characteristics of groundwater in the principal aquifer under the GE plant

| Chemical | Concentration (ppm) |
|---|---|
| Calcium (Ca) | 100 |
| Iron (Fe) | 0.09 |
| Magnesium (Mg) | 7 |
| Sodium (Na) | 57 |
| Manganese (Mn) | 0.01 |
| Bicarbonate ($HCO_3$) | 132 |
| Carbonate ($CO_3$) | 0 |
| Hydroxyl (OH) | 0 |
| Chloride (Cl) | 40 |
| Sulfate ($SO_4$) | 1 |
| Nitrate ($NO_3$) | 0 |
| Total Hardness | 107 |
| Alkalinity[1] | 123 |
| Alkalinity[2] | 0 |
| pH | 7.3 |
| Total Solids | 200 |
| Free $CO_2$ | 13 |
| Silica ($SiO_2$) | 17 |

[1]Methyl Orange
[2]Phenophthalein
Source: General Electric Environmental Report, NEDO-30153, 83 NED 051, July 1983.

## 3.6 Climatology and Meteorology

### 3.6.1 Climatology

Weather in the Wilmington area is characterized by warm, humid summers and short, mild winters. Based on data from 1941 to 1980, the annual average temperature is 63°F with a highest monthly average of 80°F occurring in July and a lowest monthly average of 50°F in January. The average annual rainfall is about 51 inches. July has the highest monthly average with roughly 7 inches of rainfall and the lowest monthly average is about 3 inches occurring in November.

### 3.6.2 Tornadoes and Hurricanes

During the 53-year period from 1916 to 1968, 192 tornadoes were reported in North Carolina. Eight tornadoes were reported in the Wilmington area between 1953 to 1962 for a mean annual frequency of about 1.0. Although hurricanes

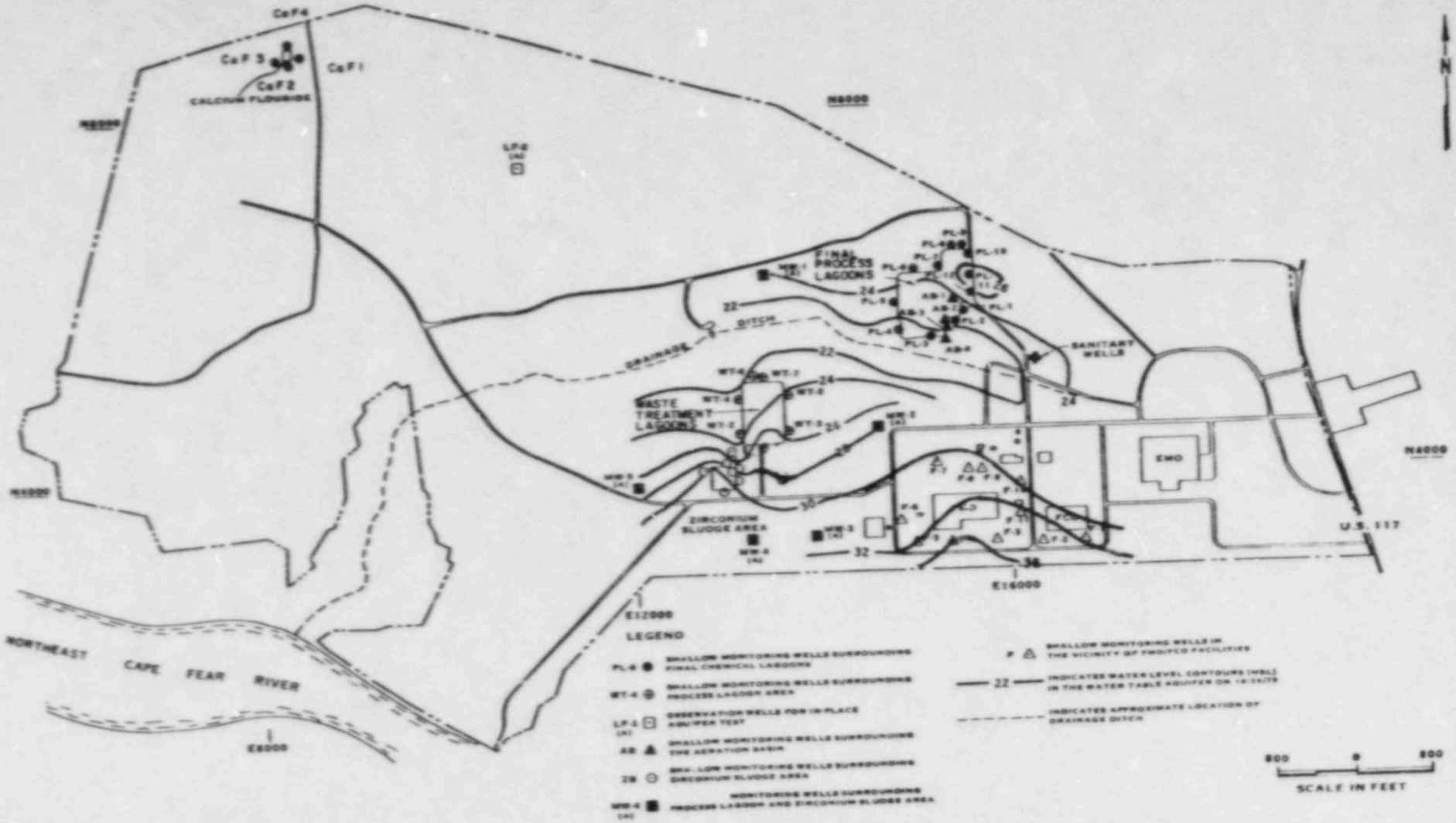


Figure 3.2 Groundwater elevations in shallow aquifer under the GE plant

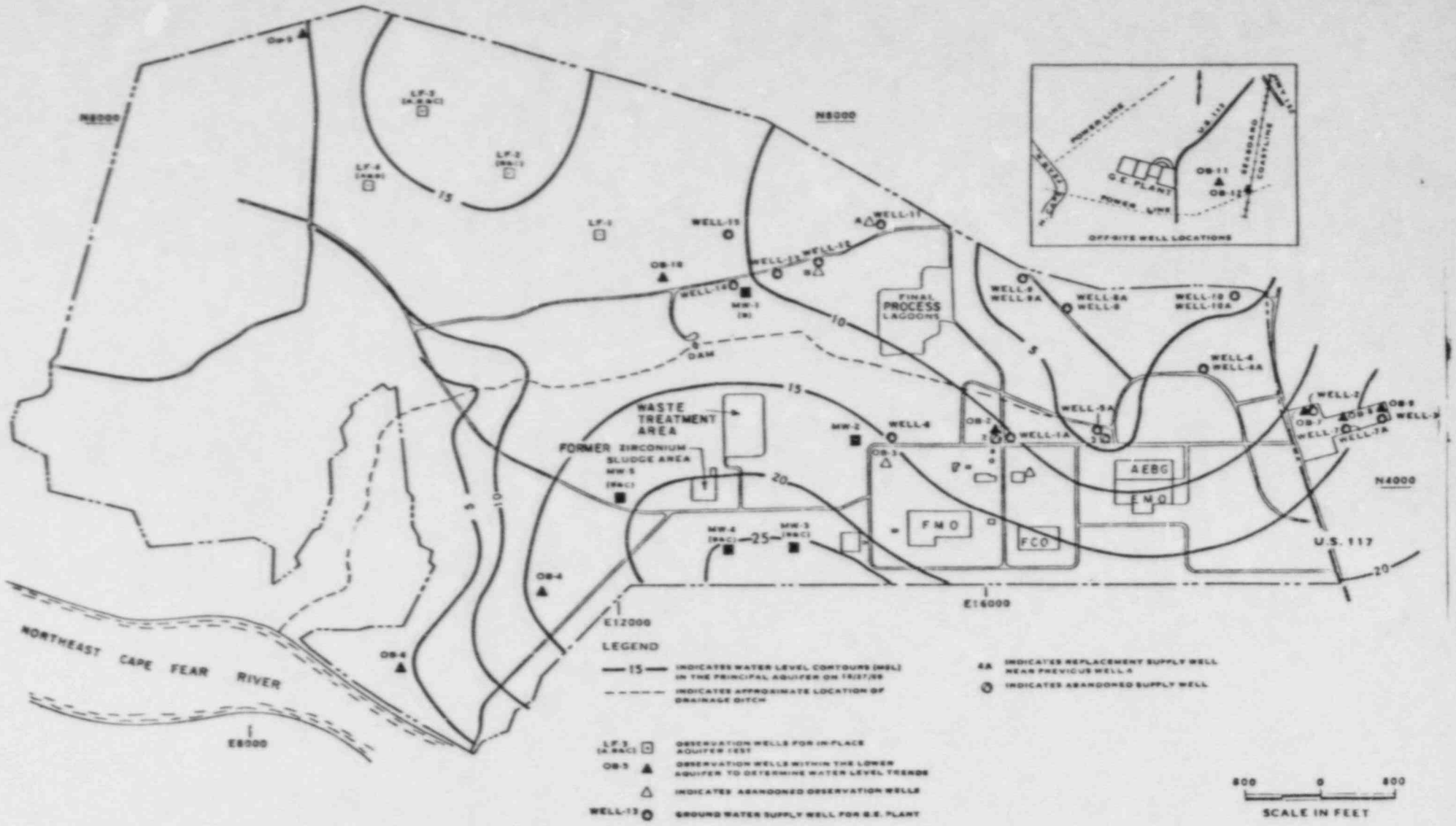


Figure 3.3 Potentiometric surface of principal aquifier under the GE plant

strike the North Carolina coast about one to three times per year, only once every 10 years does a hurricane strike the area with sufficient force to damage inland property. The strongest wind recorded in the Wilmington area was 135 mph (1958 during Hurricane Helene) and the highest tide recorded was 10 feet above normal (1955 during Hurricane Ione). GE states that the plant buildings are designed to withstand sustained winds of 125 mph with substantial margins for safety and are located 30-35 feet above the mean high tide. Thus, winds and tides equivalent to the historical highs are not expected to significantly impact the plant.[3]

### 3.6.3 Meteorology

Onsite meteorological data on wind speeds, directions, and stability class frequencies are not available from the licensee; however, meteorological characteristics for the area are measured at the New Hanover County Airport about 3.5 miles southeast of the GE site. Because of this short distance from GE and the flat, featureless terrain in between, meteorological data from the airport are considered representative of the GE site. Data on the frequency of wind speeds and directions for a single year (compiled for the 1978-1982 period) are displayed graphically as a wind rose in Figure 3.4. As shown in this figure, the predominant wind directions are toward the south and toward the northeast. The mean hourly wind speed in the vicinity of the site is 8.9 miles per hour.

Annual average atmospheric dispersion factors (X/Q) have been calculated for 16 compass sectors centered on the plant site and for distances out to 50 miles (Table 3.4). A 4-year (1966-1970) annual summary of meteorological conditions measured at the New Hanover County Airport was used in this calculation. These factors in conjunction with a measure of source term strength are used to determine the concentrations of radionuclides in air at ground levels as a function of distance and direction from the point of release. The air concentrations are in turn used to calculate doses and environmental effects caused by airborne emissions from routine operation of the GE facility (Section 4.2.5).

The X/Q values were produced using the Gaussian Plume Model and diffusion coefficients for Pasquill type turbulence as in NRC Regulatory Guide 1.111.[11] In generating the X/Q's, the contaminant release was conservatively assumed to occur at ground level with a correction for initial mixing of the plume within a building wake.

## 3.7 Ecology

### 3.7.1 Terrestrial Biota

There are 13 major biotic communities that have been identified on the GE site. Eight of the communities are natural and these are characterized by the Upland Pine-Hardwood Forest; Longleaf Pine-Turkey Oak-Wire Grass Complex; Pine-Shrub-Wire Grass Savannah; Pond Pine Pocosin; Swamp Forest; Marsh; Open Water; and Woodland Pond. Another community on the plant site is an area planted with slash pine, which does not naturally grow in the Wilmington area. The remaining four community types are old fields, excavated borrow pits, operational areas, and ditches.

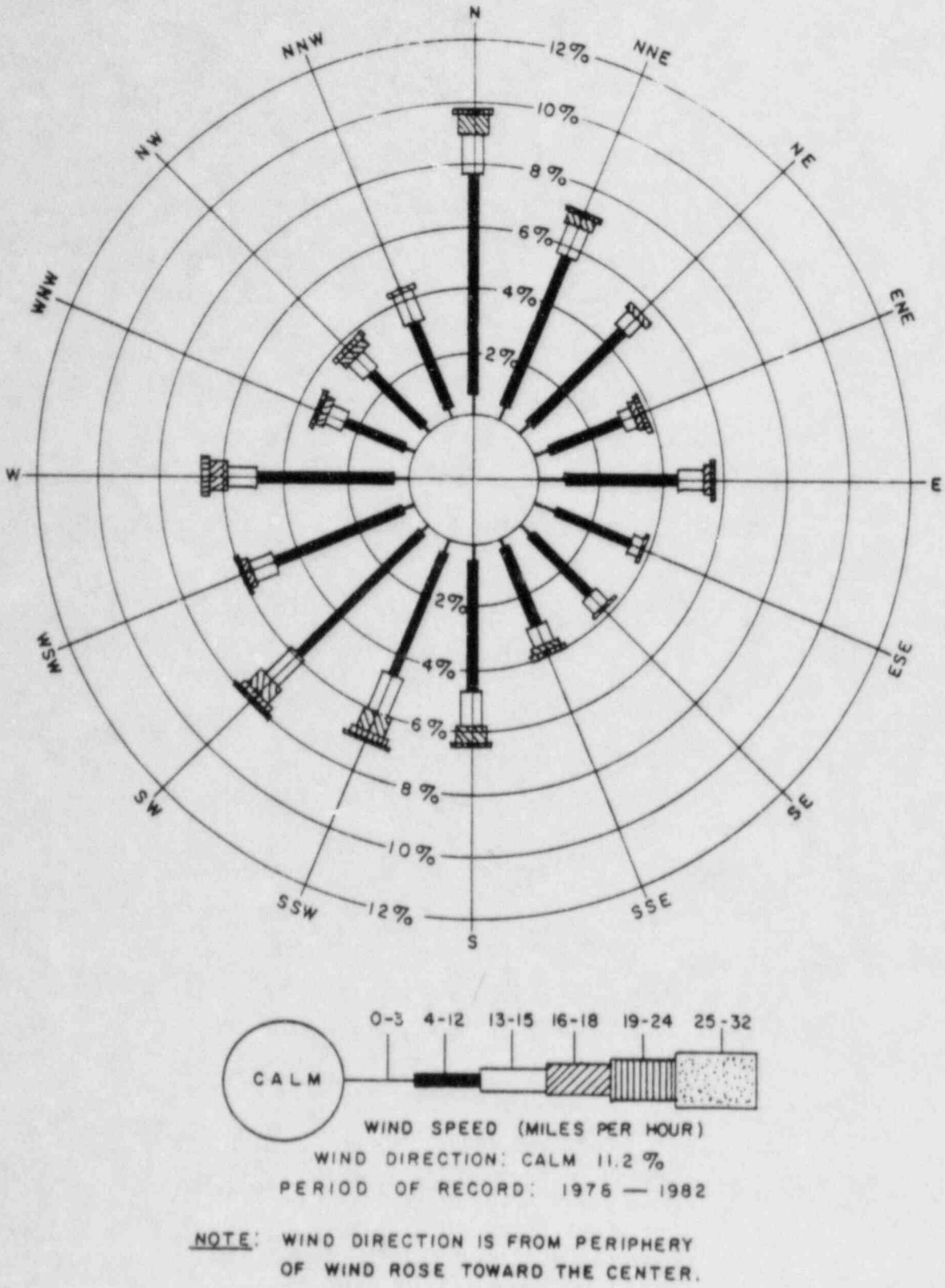


Figure 3.4 Annual wind rose for Wilmington, North Carolina for 1978-1982

Table 3.4 Annual average atmospheric dispersion factors ($\chi/Q$) ($sec/m^3$) by distance and direction from the GE plant

| | DISTANCE IN MILES | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | .500 | 1.000 | 2.000 | 3.000 | 4.000 | 5.000 | 10.000 | 20.000 | 30.000 | 40.000 | 50.000 |
| N | .349W-05 | .112E-05 | .425E-06 | .251E-06 | .172E-06 | .128E-06 | .521E-07 | .216E-07 | .129E-07 | .896E-08 | .673E-08 |
| NNE | .243E-05 | .784E-06 | .298E-06 | .175E-06 | .119E-06 | .887E-07 | .358E-07 | .148E-07 | .882E-08 | .610E-08 | .458E-08 |
| NE | .365E-05 | .118E-05 | .448E-06 | .262E-06 | .179E-06 | .133E-06 | .534E-07 | .220E-07 | .131E-07 | .905E-08 | .679E-08 |
| ENE | .326E-05 | .104E-05 | .393E-06 | .230E-06 | .157E-06 | .117E-06 | .475E-07 | .197E-07 | .118E-07 | .814E-08 | .611E-08 |
| E | .284E-05 | .905E-06 | .341E-06 | .200E-06 | .136E-06 | .101E-06 | .409E-07 | .169E-07 | .101E-07 | .697E-08 | .523E-08 |
| ESE | .162E-05 | .521E-06 | .195E-06 | .113E-06 | .771E-07 | .572E-07 | .230E-07 | .943E-08 | .560E-08 | .386E-08 | .290E-08 |
| SE | .151E-05 | .482E-06 | .180E-06 | .104E-06 | .709E-07 | .526E-07 | .211E-07 | .867E-08 | .514E-08 | .355E-08 | .266E-08 |
| SSE | .157E-05 | .507E-06 | .191E-06 | .111E-06 | .756E-07 | .561E-07 | .226E-08 | .927E-08 | .551E-08 | .380E-08 | .285E-08 |
| S | .364E-05 | .117E-05 | .442E-06 | .259E-06 | .176E-06 | .131E-06 | .530E-07 | .218E-07 | .130E-07 | .898E-08 | .674E-08 |
| SSW | .284E-05 | .927E-06 | .350E-06 | .203E-06 | .138E-06 | .102E-06 | .407E-07 | .167E-07 | .987E-08 | .680E-08 | .510E-08 |
| SW | .327E-05 | .106E-05 | .402E-06 | .235E-06 | .160E-06 | .119E-06 | .481E-07 | .198E-07 | .118E-07 | .814E-08 | .611E-08 |
| WSW | .283E-05 | .904E-06 | .343E-06 | .202E-06 | .138E-06 | .103E-06 | .418E-07 | .173E-07 | .103E-07 | .716E-08 | .538E-08 |
| W | .283E-05 | .908E-06 | .342E-06 | .200E-06 | .136E-06 | .101E-06 | .409E-07 | .168E-07 | .100E-07 | .692E-08 | .519E-08 |
| WNW | .179E-05 | .575E-06 | .216E-06 | .126E-06 | .856E-07 | .635E-07 | .255E-07 | .105E-07 | .624E-08 | .431E-08 | .323E-08 |
| NW | .159E-05 | .503E-06 | .188E-06 | .110E-06 | .751E-07 | .559E-07 | .226E-08 | .935E-08 | .557E-08 | .385E-08 | .289E-08 |
| NNW | .132E-05 | .421E-06 | .159E-06 | .931E-07 | .636E-07 | .473E-07 | .191E-07 | .790E-08 | .470E-08 | .325E-08 | .244E-08 |

Native species of plants and animals inhabit the site. A comprehensive list of the species common to the region is given in Appendix 2-3 of GE's 1974 Environmental Report.[1] The site's dominant large animal is the white-tailed deer which has been occasionally observed. GE estimates that the deer population is about one deer per 15 acres of undeveloped land. The black bear is an uncommon transient on the site, but an observation of a bear was recently made on GE's property. Other mammals in the area include the bobcat, carolina otter, oppossum, raccoon, mink, muskrat, and several species of mice, bats, and squirrels. A large number of bird species occupies the area's swamp forests, marshes, and upland vegetation

3.7.2 Aquatic Biota

Aquatic communities in the vicinity of GE's site mainly exist in the Northeast Cape Fear River and its associated tributaries and creeks. These waters contain a large variety of freshwater fish but are also important nursery areas for at least 19 species of marine finfish. At least three species of commercially valuable invertebrates are also found. Waterfowl are largely transient or winter residents in the area.

On the GE site, aquatic communities occur essentially in the main site drainage ditch (Brickyard Creek) that is a natural creek enlarged during GE's site development (Section 2.2.2.2). In the western portion of the site, this creek flows through a swamp forest and marsh which also host aquatic organisms. Brickyard Creek is small and shallow and is tidally influenced in its stretch near the Northeast Cape Fear River. Its banks are stabilized, permitting colonization by wildlife, and a mix of amphibians, reptiles, birds, insects, and vegetation exists in and around Brickyard Creek and the onsite marshes.

3.7.3 Threatened and Endangered Species

There are several animal and at least two plant species that are federally listed as threatened or endangered (50 CFR Parts 17.11 and 17.12) whose present or former geographic range include North Carolina and conceivably the GE site. The animal species include the gray bat (Myotis grisescens), peregrine falcon (Falco peregrinus), brown pelican (Pelecanus occidentalis), red-cockaded woodpecker (Picoides borealis), American alligator (Alligator mississippiensis), and pine barrens treefrog (Hyla andersonii). The two plant species are bunched arrowhead (Sagittaria fasciculata) and small whorled pagonia (Isotria medeoloides). As far as has been determined by surveys made of the site, there is no permanent presence of any threatened or endangered species on the federal or State of North Carolina lists. Several species of rare fish inhabit the Cape Fear River system, possibly in areas near the GE site. There may be a valuable nursery area for shortnose sturgeon (Acipenser brevirostrum), which is on the federal list, in lower portions of the Northeast Cape Fear River. Other fish species which depend on the area that are significant on the state level are the American and hickory shad, alewife, and blueback herring.

3.8 Background Radiological Characteristics

The State of North Carolina Department of Human Resources routinely conducts a surveillance program that provides radiological background characteristics of the area. Background values have also been determined by preoperational surveys performed by GE and by special investigations conducted by the EPA and NRC. The data most representative of background are presented in Table 3.5.

Table 3.5 Background radiological characteristics in the area of the GE plant

| Media | Background Value | Basis for Determination |
|---|---|---|
| Air | $7 \times 10^{-14}$ $\frac{\mu Ci}{ml}$ Gross β | Average of 1979-1981 results from state-operated sampler 7 miles south of GE.[12] |
| | $1.4 \times 10^{-16}$ $\frac{\mu Ci}{ml}$ for $^{234}U + ^{238}U$ | EPA survey at the New Hanover County Airport (4 miles south of GE).[13] |
| Surface Water | 1 pCi/L Gross α<br>5 pCi/L Gross β | Median of state's 1978-1981 results from the Northeast Cape Fear River, 16 miles upstream of GE.[12] |
| Ground Water | 0.2 - 1.5 $\frac{pCi}{l}$ Gross α | NRC investigation of wells in principle aquifer upgradient of GE activities. |
| Soil | 0.3 ppm uranium | Preoperational (1967) sampling by GE.[3] |

# 4. ENVIRONMENTAL CONSEQUENCES OF PROPOSED LICENSE RENEWAL

## 4.1 Monitoring Programs and Mitigatory Measures

An effluent and environmental monitoring program is conducted by GE to demonstrate compliance with appropriate environmental protection standards and to provide, where possible, site-specific data which would preclude the need to use conservative assumptions in assessing radiation exposures.

### 4.1.1 Effluent Monitoring Program

The effluent monitoring program associated with GE's fuel manufacturing operation is shown in Table 4.1. The program is discussed in detail below along with results obtained from 1978 to 1982.

Table 4.1 Effluent monitoring program associated with GE's fuel manufacturing operation

| Sample Point | No. of Samples | Collection Frequency | Sample Type[a] | Type of Analysis |
|---|---|---|---|---|
| Airborne Discharge Stacks | 33 | Daily or Weekly | C | Gross Alpha and Gross Beta[b] |
| | 5 | Weekly | C | Fluoride |
| Discharge From Final Process Lagoons | 2 | Daily | C | Uranium; gross Alpha and gross Beta (weekly) composites); Tc-99 (Semiannual composite)[b] |
| Discharge From Final Process Lagoons | 2 | Daily | C | Chromium; Copper; Nickel; Ammonia; Nitrate; Fluoride; Titanium; and Flow |
| | | Daily | G | pH and Temperature |
| | | Monthly | G | Chloride; Sulfate; Phosphate; total suspended solids; alkalinity; BOD; COD; total solids; and total dissolved solids |

Table 4.1 Continued

| Sample Point | No. of Samples | Collection Frequency | Sample Type[a] | Type of Analysis |
|---|---|---|---|---|
| Discharge from Sanitary Waste Treatment Facility | 1 | Monthly | G | Uranium and pH |
| | | Daily | G | Settleable Matter and Temperature |
| | | Daily | C | Flow and other chemicals (as 24 hour composites) |

[a] C = Continuous; G = Grab

[b] Samples and Analyses currently required by License SNM-1097

4.1.1.1 Airborne Emission Monitoring

A. Radiological

At present there are 33 release points that exhaust uranium compounds to the environment from normal operation of the GE plant (Section 2.2.2.1). Samples of exhausted air are obtained continuously from each release point while in use. Sampling installations include a probe inserted in the air stream, delivery lines, filter paper sampler, sample pump, flow control valve, and a flow measuring device. According to GE, isokinetic sampling conditions are approximated but are not strictly maintained. HEPA filters are designed to remove 99.97% of all particles .3 μm in diameter or larger; thus, particles not removed by HEPA filtration would predominantly be smaller than .3 μm. With particles this size, errors caused by anisokinetic sampling are reported to be small.[14] The filter papers are changed daily or weekly, depending on the potential for discharge, and routinely counted for alpha activity. If any daily or weekly result exceeds $3 \times 10^{-12}$ μCi/ml (the most restrictive release limit in 10 CFR 20, Appendix B, Table II for a uranium isotope that may be emitted by GE), action is taken by GE in accordance with the license. The total volumes and gross alpha activities discharged during the years 1978 - 1982 are presented in Table 4.2. The elevated release in 1978 is partly explained by an accident in December 1978 during which $UF_6$ gas was released indoors and subsequently into the ventilation system. As a result, approximately 1800 μCi were released to the environment.[15] Other $UF_6$ releases are reported to have occurred since then resulting in smaller releases of radioactivity to the atmosphere. GE's production rate during this period has increased and, therefore, improved effluent control has contributed to the downward trend in total activity and activity concentration shown in Table 4.2.

Table 4.2 Annual volume and gross alpha activity discharged to the atmosphere for the years 1978 - 1982

| Year | No. of Release Points | Volume Discharged[a] ($10^{15}$ ml) | Total Gross Alpha Activity (Microcuries) | Average Concentration At Points of Discharge ($10^{-12}$ µCi/ml) |
|---|---|---|---|---|
| 1978 | 29 | 1.4 | 4092 | 2.9 |
| 1979 | 29 | 4.0 | 1694 | 0.4 |
| 1980 | 31 | 3.6 | 1051 | 0.3 |
| 1981 | 31 | 4.0 | 1105 | 0.3 |
| 1982 | 33 | 4.2 | 624 | 0.2 |

[a]Annual volume released from plant operation 7 days per week

Source: General Electric Environmental Report, NEDO-30153, 83 NED 051, July 1983

B. Nonradiological

The waste incinerator and 4 discharge points from the chemical conversion operations emit fluorides to the atmosphere. The exhaust from these points is monitored continuously using the same kind of sampling mechanism described above for uranium sampling. The filter papers, which are treated with calcium carbonate to enhance fluoride retention, are changed weekly and analyzed for fluoride content. Annual results from the Fuel Manufacturing Building for the years 1978 - 1982 are shown in Table 4.3. The incinerator was not used prior to April 1982 so fluoride release data for the incinerator are not included in Table 4.3, but monitoring since the incinerator startup shows that its release contains approximately 0.2 µg/m$^3$ of fluoride.

Table 4.3 Annual fluoride discharges to the atmosphere from fuel manufacturing operations for the years 1978 - 1982

| Year | Total Fluorides Discharged (grams) | Discharged Volume ($10^{15}$ cc) | Fluoride Year Concentration (µg/m$^3$) |
|---|---|---|---|
| 1978 | 3642 | 0.493 | 7.4 |
| 1979 | 3375 | 0.853 | 4.0 |
| 1980 | 5897 | 0.808 | 7.3 |
| 1981 | 2518 | 0.769 | 3.3 |
| 1982 | 7460 | 0.828 | 9.0 |

Source: General Electric Environmental Report, NEDO-30153, 83 NED 051, July 1983

Neither the EPA nor the State of North Carolina have emission or ambient air standards for fluorides. OSHA/NIOSH[a] has set permissible exposure limits of 2500 $\mu g/m^3$ for fluoride dust and 2000 $\mu g/m^3$ for hydrogen fluoride.[16] The fluoride concentrations to the point of release from GE's Fuel Manufacturing Building are well below these ambient air standards. GE does not currently monitor for fluoride in the ambient air but fenceline concentrations would be even lower following dispersion in the atmosphere. The $\chi/Q$ at the nearest site boundary in the predominant wind direction (to the south) is $6.9 \times 10^{-5}$ $sec/m^3$, assuming a ground level release and building wake effect. Using this $\chi/Q$ and the maximum annual fluoride release shown in Table 4.3, fuel manufacturing operations during the 1978-1982 period resulted in a calculated maximum fluoride concentration of 0.02 $\mu g/m^3$ in air at the nearest boundary. This air concentration is well below the recognized threshold of 0.5 $\mu g/m^3$ for effects on sensitive plant species.[17]

As previously mentioned in Section 2.2.2.1, other GE operations not involved with uranium processing also release fluorides to the atmosphere. GE states that in 1983 operations in their Fuel Components Building and Aircraft Engine Manufacturing Building released about 195 kg and 5.2 kg of fluoride, respectively (C. Vaughan, GE, Telephone Communication with S. Wyngarden, April 27, 1984). Using the same $\chi/Q$ as above, these emissions result in ambient air concentrations of 0.4 $\mu g/m^3$ and 0.01 $\mu g/m^3$, respectively at the south boundary. GE has reported that the filter paper samplers at the point of release have a fluoride collection efficiency of approximately 74%. Recognizing this efficiency and the uncertainties associated with this type of modeling, the concentration of fluoride in air at the site boundary resulting from all sources at GE approaches 0.5 $\mu g/m^3$. This concentration may produce signs of fluoride injury (e.g., browning of leaf margins) in sensitive plant species such as conifers, gladiolus and sorghum, but greatly reduced productivity or death of plants is unlikely at these levels.[17] Accumulations of fluoride in vegetation of 40 ppm or greater has been known to cause fluorosis in grazing animals.[17, 18] In a special investigation by GE, sampled pine needles from trees onsite were found to contain a maximum of 3.4 ppm[3]; however, the fluoride content in vegetation that could be used for forage has not been examined. In order to demonstrate that the total fluoride released from GE operations is not impacting the environment and to provide information for future environmental assessments, GE will be required to sample possible forage vegetation (grass) onsite and analyze for fluoride on a semi-annual basis.

4.1.1.2 Liquid Effluent Monitoring

A. Radiological

All process waste liquids (with the exception of nitrate wastes) are treated and collected in 2 final process lagoons (Sect. 2.2.2.2). The effluent from each lagoon flows into a drainage ditch to the site dam and then to the Northeast Cape Fear River. This effluent is sampled on a composite basis proportionate to the discharge flow (which normally provides a sample every 1000 gallons discharged) and analyzed daily for uranium. A weekly composite of the daily samples is analyzed for gross alpha and beta activity and, since 1983, a 6-month

[a]Occupational Safety and Health Administration/National Institute for Occupational Safety and Health

composite made from the weekly samples is analyzed for technetium-99. Monitoring results for uranium, gross alpha, and gross beta for the years 1978 - 1982 are presented in Table 4.4. The average $^{235}U$ enrichment in 1983 at GE was about 2.5%, which is slightly higher than the average for previous years (C. Vaughan, GE, Telephone Communication with S. Wyngarden, June 5, 1984). At 2.5% enrichment, the maximum uranium content shown in Table 4.4 (1.7 ppm in 1980) equates to approximately 8% of the release limit for uranium to unrestricted waters.

Table 4.4 Annual radioactivity concentrations in final process lagoon effluent for the years 1978 - 1982

| Year | Uranium Content (ppm) | | | Gross α ($10^{-7}$ μCi/ml) | | | Gross β ($10^{-7}$ μCi/ml) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Ave | Min | Max | Ave | Min | Max | Ave | Min | Max |
| 1978 | 0.5 | 0.2 | 1.2 | 6.3 | 1.2 | 43.0 | 7.3 | 1.2 | 27.0 |
| 1979 | 0.5 | 0.2 | 1.5 | 7.1 | 0.7 | 17.0 | 7.2 | 2.0 | 29.0 |
| 1980 | 0.7 | 0.3 | 1.7 | 6.7 | 1.2 | 16.0 | 5.8 | 0.4 | 13.0 |
| 1981 | 0.6 | 0.2 | 1.3 | 7.3 | 0.9 | 61.0 | 5.9 | 1.0 | 19.0 |
| 1982 | 0.5 | 0.2 | 1.2 | 6.2 | 1.0 | 15.0 | 7.3 | 1.3 | 19.0 |

Source: General Electric Environmental Report, NEDO-30153, 83 NED 051, July 1983

GE also monitors for uranium in discharge from their sanitary waste treatment facility. For the 1978 - 1982 period, the maximum annual uranium release from this facility reported by GE is less than 0.04 ppm ($5.5 \times 10^{-8}$ μCi/ml at 2.5% enrichment) or approximately 0.2% the 10 CFR 20 release limit.

B. Nonradiological

Monitoring for nonradiological parameters in effluent from the final process lagoons and sanitary waste treatment facility is performed in accordance with a state-issued NPDES permit. Contaminants of primary concern in the process wastewater are nitrogen containing compounds (i.e., ammonia, nitrite, and nitrate), fluoride, copper, nickel, and chromium. Composite samples from the final lagoon effluent are analyzed for these parameters on a daily basis and separate grab samples are collected for pH and temperature measurements. Grab samples from the final lagoon effluent are also collected monthly and analyzed for other chemicals (shown in Table 4.1). Effluent from GE's final process lagoons during the 1978 - 1982 period met discharge limitations specified in the NPDES permit as demonstrated in Table 4.5.

GE's NPDES permit requires monitoring of the sanitary effluent for several chemical parameters. Except for a violation of the NPDES limit for total suspended solids in July, 1981, effluent from the sanitary waste treatment facility has also complied with discharge limitations.[3]

Under their NPDES authority, the State's Division of Environmental Management sets and enforces nonradiological effluent limitations for GE. Under NEPA however, the NRC's environmental assessments of GE operations are required to evaluate the impact of both radiological and nonradiological contaminants. In

Table 4.5 NPDES discharge limitations and annual nonradiological releases from the final process lagoons for the years 1978 - 1982

| Parameter | | NPDES Limit | Annual Results 1978 | 1979 | 1980 | 1981 | 1982 |
|---|---|---|---|---|---|---|---|
| Fluoride (Pounds) | daily max | 160 | 75 | 150 | 128 | 91 | 39 |
| | monthly ave[a] | 80 | 14 | 25 | 20 | 19 | 12 |
| Nitrogen-Total of combined nitrogen in ammonia, nitrate, and nitrite (pounds) | daily max | 210 | 135 | 202 | 198 | 196 | 188 |
| | monthly ave | 145 | 36 | 58 | 45 | 54 | 55 |
| Chromium (pounds) | daily max | 1.0 | .81 | 1.0 | .46 | .74 | .26 |
| | monthly ave | 0.5 | .08 | .07 | .06 | .08 | .06 |
| Copper (pounds) | daily max | 2.1 | .86 | .48 | .42 | .45 | .76 |
| | monthly ave | 1.0 | .07 | .07 | .06 | .08 | .08 |
| Nickel (pounds) | daily max | 1.0 | .57 | .33 | .41 | .38 | .27 |
| | monthly ave | 0.5 | .07 | .08 | .06 | .09 | .09 |
| Volume ($10^3$ gallons) | daily max | 2400 | 2000 | 2296 | 2080 | 1974 | 1786 |
| | monthly ave | 1800 | 576 | 642 | 506 | 561 | 551 |
| pH (units) | Range | 6.0-9.0 | 6.1-9.0 | 6.1-9.0 | 6.0-9.0 | 6.3-9.0 | 6.0-8.9 |

[a]Average values reported are the annual average of monthly values - GE states that discharges for each individual month were also below permit conditions.

Source: GE Environmental Report, NEDO-30153, 83 NED 051, July 1983

order to avoid duplicative enforcement responsibilities between the state and NRC but not to compromise the NRC's responsibilities under NEPA, the staff will require GE to report violations of the NPDES permit to the NRC. This reporting requirement is particularly important for NPDES-required monitoring of nonradiological contaminants in the groundwater, which could provide the NRC with an early warning of a leak potentially allowing radioactive material to enter the groundwater (Section 4.1.2.3).

4.1.2 Environmental Monitoring Program

The environmental monitoring program associated with fuel production activities at GE is shown in Table 4.6 and recent results are discussed below.

Table 4.6 Environmental monitoring program associated with GE's fuel manufacturing operation

| Sample Point | No. of Samples | Collection Frequency | Sample Type[a] | Type of Analysis |
|---|---|---|---|---|
| Air | | | | |
| Ambient air stations | 4 | Weekly | C | Gross alpha (uranium isotopes on monthly basis)[b] |
| Surface Water | | | | |
| Dam in drainage ditch | 1 | Daily | G | Uranium; several nonradiological parameters |
| Northeast Cape Fear River - upstream and downstram | 1 each | Monthly | G | Uranium[b]; BOD; fecal coliform |
| Northeast Cape Fear River - GE dock | 1 | Weekly | C | Uranium; several nonradiological parameters |
| Cape Fear River - upstream and downstream | 1 each | Quarterly | G | Gross alpha and gross beta[b] |
| Groundwater | | | | |
| WT series wells | 8 | Monthly | G | Uranium, gross alpha, and gross beta[b]<br>pH; ammonia; nitrate; fluoride; total dissolved solids |
| PL series wells | 5 | Quarterly | G | Uranium, gros alpha, and gross beta[b]<br>pH; ammonia; nitrate; fluoride; total dissolved solids |
| Z series wells | 6 | Monthly | G | Uranium[b]<br>pH; ammonia; nitrate; fluoride; total dissolved solids |

Table 4.6 Continued

| Sample Point | No. of Samples | Collection Frequency | Sample Type[a] | Type of Analysis |
|---|---|---|---|---|
| CaF series wells | 4 | Quarterly | G | Uranium, gross alpha, and gross beta[b]<br><br>Fluoride; total dissolved solids |
| Combined supply inlet | 1 | Monthly | G | Uranium[b]; several nonradiological parameters |
| Supply wells No. 9, 11, 14 | 1 each | Monthly | G | Uranium; nitrate; total dissolved solids; fluoride (no. 9 only) |
| Wells MW5A and MW5C | 1 each | Quarterly | G | Uranium (MW5C only); nitrate; total dissolved solids |
| Area | | | | |
| Soil | 16 | Quarterly | G | Uranium[b] |

[a]C = Continuous; G = Grab

[b]Samples and analyses currently required by License SNM-1097

4.1.2.1 Ambient Air Monitoring

A. Radiological

Since 1980 four air sampling stations have been operated on the GE site (Figure 4.1) to provide a continuous measure of gross alpha activity in airborne particulates. The stations are located in predominant wind directions from fuel manufacturing operations (see Figure 3.4), along the nearest site boundary, and in the direction of nearest offsite residences. Activity collected by these samplers is analyzed for uranium isotopes on a monthly basis. Annual results for gross alpha and isotopic concentrations are presented in Table 4.7.

Using the gross alpha source term of 624 μCi released to the air during 1982 (reported in Table 4.2) and the $\chi/Q$ of $6.9 \times 10^{-5}$ sec/m$^3$ for the south boundary, the calculated air concentration at the south sampling station is $1.3 \times 10^{-15}$ μCi/ml. This compares very well with the measured value of $1.2 \times 10^{-15}$ μCi/ml at that station in 1982.

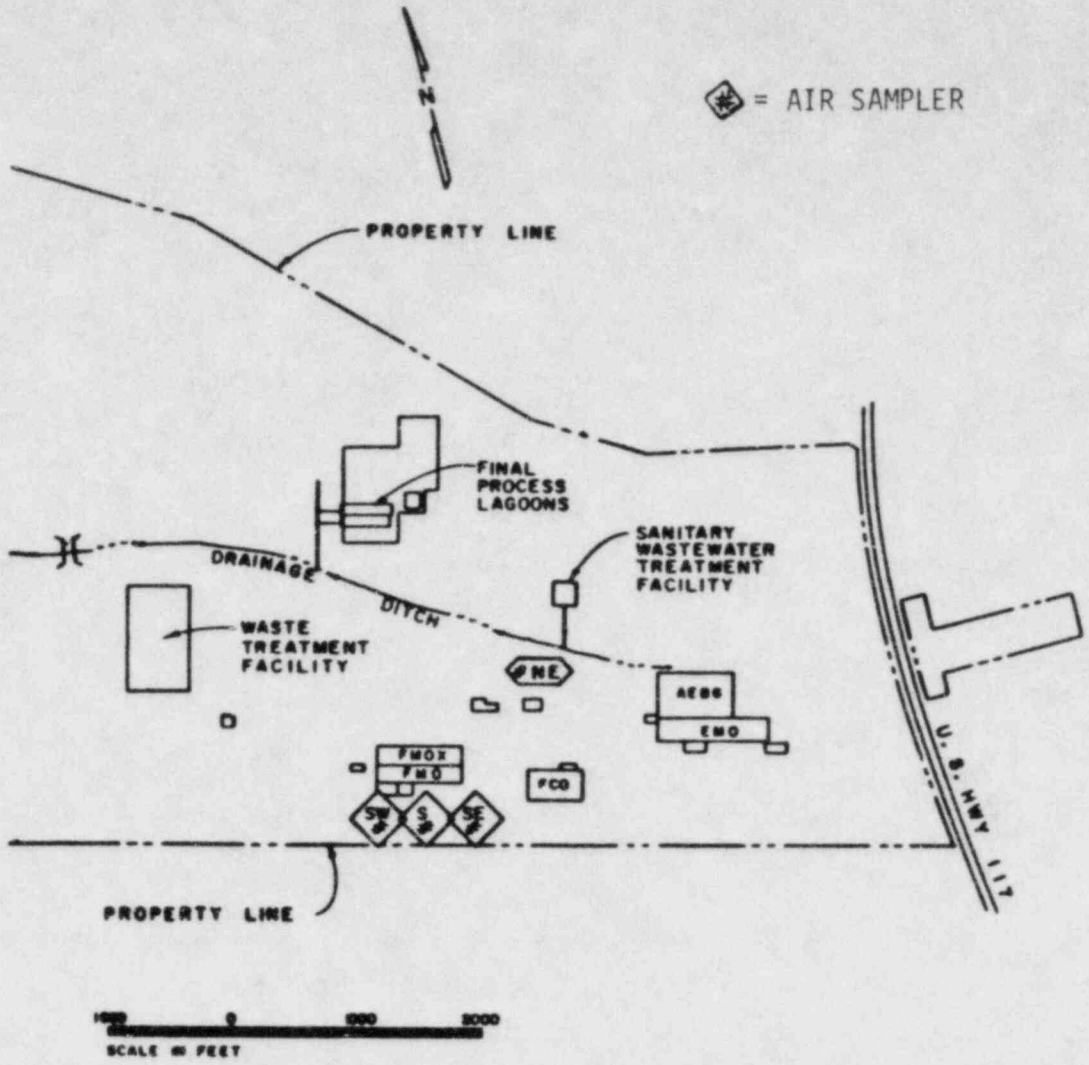


Figure 4.1 Locations of ambient air sampling stations

Table 4.7 Gross alpha and isotopic concentrations in ambient air from 1980 to 1982

| Year | Parameter | Sampling Station SE | | | S | | | SW | | | NE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Min | Ave | Max | Min | Ave | Max | Min | Ave | Max | Min | Ave | Max |
| 1980 | Gross α[a] | 6 | 15 | 25 | 6 | 19 | 54 | 6 | 36 | 230 | 5 | 14 | 27 |
| | $^{238}U$[b] | <5 | <9 | 12 | 7 | 15 | 23 | 2 | 13 | 22 | 10 | 16 | 28 |
| | $^{235}U$ | <2 | <2 | <3 | <3 | <3 | <3 | <2 | <4 | <8 | <2 | <3 | 6 |
| | $^{234}U$ | 14 | 24 | 45 | 6 | 16 | 34 | 6 | 43 | 76 | 16 | 31 | 49 |
| 1981 | Gross α | 5 | 11 | 24 | 4 | 14 | 47 | 6 | 18 | 47 | 3 | 13 | 55 |
| | $^{238}U$ | <9 | <13 | 230 | <7 | <29 | 81 | <7 | <43 | 106 | <6 | <37 | 109 |
| | $^{235}U$ | 4 | 12 | 64 | 2 | <8 | <35 | <2 | <10 | <33 | <4 | <13 | <48 |
| | $^{234}U$ | <9 | <50 | 225 | <6 | <38 | 63 | 27 | 69 | 138 | <9 | <41 | 97 |
| 1982 | Gross α | 5 | 12 | 36 | 3 | 12 | 26 | 3 | 14 | 36 | 5 | 12 | 61 |
| | $^{238}U$ | <9 | <35 | 87 | <5 | <76 | 333 | 15 | 55 | 219 | 5 | 81 | 425 |
| | $^{235}U$ | <3 | <8 | <14 | <3 | <7 | <18 | <3 | <9 | <20 | <3 | <8 | <13 |
| | $^{234}U$ | 13 | 80 | 293 | <6 | <71 | 264 | 32 | 86 | 163 | 5 | 94 | 421 |

[a] Gross α Concentrations x $10^{-16}$ μCi/ml

[b] Isotopic Concentrations x $10^{-17}$ μCi/ml

Source: General Electric Environmental Report, NEDO-30153, 83 NED 051, July 1983

To ensure compliance with dose limits for the uranium fuel cycle (40 CFR 190), License SNM-1097 requires GE to determine the uranium solubility and particle size distribution of airborne particulates if an average quarterly result from the air sampling program exceeds $3.45 \times 10^{-15}$ μCi/ml. GE reports that no results have exceeded this action level to date.

B. Nonradiological

As previously discussed in Section 4.1.1.1 (B), GE does not currently monitor for fluoride in the ambient air. Atmospheric dispersion calculations indicate that fuel manufacturing operations result in airborne fluoride concentrations at the nearest boundary that are far below applicable standards for human health and environmental protection. To demonstrate, however, that fluoride is not accumulating in forage vegetation to levels that could cause fluorosis in grazing animals and to provide useful information for future environmental assessments, GE will be required to monitor for fluoride in onsite vegetation on at least a semiannual basis.

4.1.2.2. Surface Water Monitoring

A. Radiological

In accordance with the license, the Northeast Cape Fear River is sampled upstream and downstream from the GE site and analyzed for uranium content on a monthly basis. These samples are supplemented by weekly composite samples from the river adjacent to the south property boundary (at the GE dock). Samples collected at the GE dock are also analyzed for uranium. Results for the Northeast Cape Fear River for the 1978 - 1982 period are shown in Table 4.8. These data show that uranium concentrations in the river are essentially the same at points upstream and downstream of the GE outfall. Values at the GE dock, which is closer to the outfall and the effluent mixing zone, are slightly elevated but are also consistent with upstream results. The average downstream concentration for the period is <.01 ppm uranium which at 2.5% enrichment is equivalent to 13.7 pCi/L. Even though the river is not used for drinking water (Section 3.5.1), for comparison purposes the gross alpha drinking water limit is 15 pCi/L.

Table 4.8 Annual uranium concentrations[a] in the northeast Cape Fear River for the years 1978 - 1982

| Year | Sample Point | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Upstream | | | GE Dock | | | Downstream | | |
| | Min | Ave | Max | Min | Ave | Max | Min | Ave | Max |
| 1978 | <.01 | <.01 | <.01 | <.01 | <.01 | .02 | <.01 | <.01 | <.01 |
| 1979 | <.01 | <.01 | <.01 | <.01 | <.01 | .03 | <.01 | <.01 | <.01 |
| 1980 | <.01 | <.01 | .01 | <.01 | <.01 | .01 | <.01 | <.01 | .01 |
| 1981 | <.01 | <.01 | .02 | <.01 | <.01 | .02 | <.01 | <.01 | .02 |
| 1982 | <.02 | <.02 | .05 | <.02 | <.03 | .13 | <.02 | <.02 | .05 |

[a]Uranium concentrations in ppm

Source: General Electric Environmental Report, NEDO-30153, 83 NED 051, July 1983

Daily grab samples are collected in the effluent drainage ditch at the dam and analyzed for uranium. This sampling is performed by GE on an audit basis for assurance that control systems are functioning.

As discussed in Section 2.2.2.2, GE's treated nitrate wastes are transferred to a local paper manufacturer. This waste solution is ultmately dischargd to the Cape Fear River by the paper company. The river is sampled at points upstream and downstream of the paper company outfall and analyzed for gross alpha and beta activity. Monitoring results for 1978 through 1982 show that the downstream values are slightly elevated compared to upstream and that there is generally an increasing trend for the period at both the upstream and downstream locations. This monitoring will be continued and the staff will examine future results to identify impacts on the Cap Fear River.

B. Nonradiological

In accordance with their NPDES permit, GE monitors the Northeast Cape Fear River upstream and downstream of the plant outfall for nonradiological parameters. The samples collected at the GE dock are also analyzed for chemical concentrations. Annual average results from these sampling points during the 1978 - 1982 period for ammonia, nitrate, and fluoride are shown in Table 4.9.

Table 4.9 1978 - 1982 annual average concentrations[a] of Nonradiological parameters in the northeast Cape Fear River

| Year | Sample Point: Upstream | | | GE Dock | | | Downstream | | |
|---|---|---|---|---|---|---|---|---|---|
| | $NH_3$ | $NO_3$ | F | $NH_3$ | $NO_3$ | F | $NH_3$ | $NO_3$ | F |
| 1978 | .58 | 1.1 | .11 | -[b] | 1.3 | <.16 | .45 | 1.7 | <.24 |
| 1979 | .89 | 1.1 | .16 | - | 1.2 | <.17 | .70 | 1.4 | <.21 |
| 1980 | .89 | 1.8 | .25 | - | 1.8 | .33 | .58 | 2.1 | .39 |
| 1981 | .84 | 2.4 | .17 | - | 2.0 | .21 | .68 | 2.1 | .31 |
| 1982 | 1.86 | 1.9 | .16 | - | 1.4 | .19 | 1.7 | 1.9 | .21 |

[a]Concentrations in ppm

[b]$NH_3$ analyses not performed at the GE dock

Source: General Electric Environmental Report, NEDO-30153, 83 NED 051, July 1983.

As shown in Table 4.9, the concentrations of ammonia and nitrate do not differ significantly at the upstream, downstream, and dock (for nitrates) sampling stations; however, fluoride concentrations are slightly higher below the plant. Using the maximum daily fluoride release in the past 5 years (150 lbs in 1979) and the average flow rate of the river ($635 \times 10^6$ gallons/day)[3], the calculated maximum increase in fluoride resulting from GE dicharges is 0.03 ppm. Therefore, the elevated downstream concentrations of fluoride cannot be solely attributed to GE and may be the result of other sources in the area.

In addition, the upstream and downstream samples are analyzed for pH, temperature, biochemical oxygen demand, dissolved oxygen, and fecal coliform. During the 1978-1982 period, the concentrations of these other parameters, except for fecal coliform, did not differ significantly from upstream to downstream. The concentrations of fecal coliforms below the plant were slightly elevated, but were still well below the state's limit applicable to the Northeast Cape Fear River.[19] The dock samples are also analyzed for other parameters, including metals if a metal concentration at the lagoon outfall exceeds an action guide. Metal concentrations in the dock samples from 1978 to 1982 were within EPA drinking water standards.

Liquids in the effluent drainage ditch at the site dam are sampled and analyzed for several nonradiological parameters to audit treatment system performance.

4.1.2.3 Groundwater Monitoring

Groundwater monitoring at GE is required by the State of North Carolina (under their NPDES authority) and by the NRC. The NRC-required monitoring is strictly for radiological parameters and monitoring required by the state is primarily for nonradiological contaminants. The particular wells that are required by the NRC and/or state along with the sampling frequencies and types of analyses are outlined in Table 4.6. These wells are intended to monitor both the water table and principal aquifers (Sect. 3.5.2) and their locations are shown in Figures 3.2 and 3.3.

GE's NPDES permit is in the process of being renewed by the state and is expected to be reissued in the near future. The state has recently adopted new classifications and standards for groundwater that, among other things, require compliance with quality criteria at points at least 20 feet below land surface and 500 feet from a potential source of contamination.[20] The state's groundwater monitoring requirements at GE will be appropriately modified to reflect these standards. Because nonradiological contamination in the groundwater will provide an early warning of a possible leak of radioactive material, the staff will recommend that the state also continue their existing nonradiological monitoring requirements at GE.

A. <u>WT Series Wells</u>

The 8 WT wells are used to monitor the shallow aquifer around the waste treatment lagoons. During the 1978-1983 period, only well WT-1 contained significant radioactive contamination. The radiological monitoring results for this well are shown in Table 4.10. The other WT wells contained an average uranium concentration for each year below GE's limit of detectability; however, elevated levels of nitrate and ammonia were observed in several WT wells. Nonradiological monitoring results for the past 6 years are shown in Table 4.11. The annual average nitrate concentrations in wells WT-1, 2, 4, 7, and 9 occasionally exceeded EPA's drinking water limit of 43 ppm, although the shallow aquifer is not used as a drinking water supply. The EPA has established a limit for the protection of freshwater aquatic life of 0.02 ppm un-ionized ammonia which, at typical ambient temperatures and measured pH values (20°C and a pH of 6.5), equates to a total ammonia concentration of 16 ppm. The ammonia concentrations measured in the WT wells rarely exceeded this limit. Wells WT-1 and WT-4 also contained slightly elevated fluoride levels. The maximum fluoride concentration

measured was 3.2 ppm (well WT-4 in 1979). For comparison, GE's NPDES permit allows daily fluoride discharges in the liquid effluent of 8 ppm.

GE states that these elevated concentrations were caused most recently in 1978 by a damaged sump in the adjacent waste treatment facility and a damaged manhole between the nitrate lagoons. The leaks have since been repaired and as shown in Tables 4.10 and 4.11, the contamination in the W1 wells has been decreasing. The staff, however, is concerned that residual contamination from previous releases will decrease the effectiveness of the WT wells in detecting new lagoon leaks (Sect. 4.1.3).

Table 4.10 Annual radiological monitoring results from well WT-1 for 1978-1983

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1983[a] |
|---|---|---|---|---|---|---|---|
| | Uranium (ppm) | | | | | | Gross Alpha (pCi/l) |
| Ave | 0.22 | 0.16 | 0.19 | 0.10 | 0.08 | 0.08 | 160 |
| Min | 0[b] | 0.05 | 0.06 | 0 | 0 | 0 | 87 |
| Max | 0.73 | 0.32 | 0.31 | 0.32 | 0.18 | 0.32 | 230 |

[a]Gross alpha analyses added to the program in 1983.

[b]0 = Less than detectable (0.01 for 1978-81 and 0.02 in 1982 and 1983).

Source: GE Environmental Report, NEDO-30153, 83 NED 051, July 1983 and GE submittal to the NRC dated February 10, 1984[6]

Table 4.11 Annual average nonradiological monitoring results for the WT series wells for 1978-1983

| Well | Year | Fluoride (ppm) | Nitrate (ppm) | Ammonia (ppm) |
|---|---|---|---|---|
| WT-1 | 1978 | 1.2 | 72.9 | 6.4 |
| | 1979 | 0.9 | 42.4 | 0.3 |
| | 1980 | 1.2 | 43.9 | 0.8 |
| | 1981 | 1.2 | 103.0 | 22.7 |
| | 1982 | 1.1 | 27.8 | 0.3 |
| | 1983 | 1.3 | 5.6 | .91 |
| WT-2 | 1978 | 0.1 | 49.2 | 0.6 |
| | 1979 | 0.2 | 43.6 | 0.8 |
| | 1980 | 0.3 | 13.8 | 1.1 |
| | 1981 | 0.1 | 11.8 | 0.8 |
| | 1982 | 0.2 | 8.5 | 0.8 |
| | 1983 | 0.3 | 2.6 | 1.8 |

Table 4.11 Continued

| Well | Year | Fluoride (ppm) | Nitrate (ppm) | Ammonia (ppm) |
|---|---|---|---|---|
| WT-3 | 1978 | 0.1 | 3.8 | 2.3 |
| | 1979 | 0.2 | 6.2 | 3.6 |
| | 1980 | 0.3 | 3.1 | 3.1 |
| | 1981 | 0.1 | 20.2 | 4.0 |
| | 1982 | 0.1 | 2.3 | 2.7 |
| | 1983 | 0.2 | 1.2 | 2.4 |
| WT-4 | 1978 | 0.2 | 397 | 72.3 |
| | 1979 | 1.7 | 251 | 45.0 |
| | 1980 | 1.2 | 163 | 24.3 |
| | 1981 | 1.0 | 126 | 7.3 |
| | 1982 | 0.5 | 36 | 0.8 |
| | 1983 | 0.6 | 4.9 | 1.8 |
| WT-5 | 1978 | 0.1 | 1.3 | 2.4 |
| | 1979 | 0.1 | 1.0 | 3.0 |
| | 1980 | 0.3 | 1.1 | 2.5 |
| | 1981 | 0.2 | 2.1 | 4.2 |
| | 1982 | 0.1 | 0.9 | 2.8 |
| | 1983 | 0.2 | 0.4 | 3.4 |
| WT-6 | 1978 | 0.1 | 6.2 | 9.6 |
| | 1979 | 0.1 | 2.5 | 21.2 |
| | 1980 | 0.4 | 4.6 | 11.5 |
| | 1981 | 0.2 | 3.2 | 11.0 |
| | 1982 | 0.1 | 7.0 | 5.7 |
| | 1983 | 0.2 | 1.0 | 5.6 |
| WT-7 | 1978 | 0.1 | 93.7 | 2.1 |
| | 1979 | 0.1 | 64.5 | 0.7 |
| | 1980 | 0.3 | 18.4 | 0.7 |
| | 1981 | 0.2 | 18.2 | 0.8 |
| | 1982 | 0.1 | 7.7 | 1.0 |
| | 1983 | 0.4 | 2.3 | 2.2 |
| WT-9 | 1978 | 0.1 | 66.1 | 0.2 |
| | 1979 | 0.1 | 30.0 | 0.3 |
| | 1980 | 0.3 | 38.1 | 0.2 |
| | 1981 | 0.1 | 18.0 | 0.01 |
| | 1982 | 0.1 | 17.9 | 0.3 |
| | 1983 | 0.2 | 3.1 | 0.7 |

Source: GE Environmental Report, NEDO-30153, 83 NED 051, July 1983 and GE submittal to the NRC dated February 10, 1984[6]

B. Z Series Wells

Uranium-contaminated zirconium sludge was stored onsite from 1976 to 1982 (Sect. 2.2.2.3). There are 6 shallow wells that surround the zirconium sludge

area. Nonradiological monitoring results for the past 6 years from these Z series wells are presented in Table 4.12. As shown in this table, there was significant migration of nitrates and ammonia during the period, which led to the removal and disposition of the sludge in a licensed burial ground. Excavation activities required to remove the sludge (completed in December 1982) resulted in a flushing of contaminants and a surge of nitrates in 1983 was observed in downgradient wells ZC and ZE. Prior to that time there had been little migration of radioactive material, but in 1983 the radioactivity in downgradient wells also increased sharply. The maximum gross alpha values observed were 290 pCi/l in well ZC and 66 pCi/l in well ZE. As a result, GE installed downgradient interceptor trenches in early 1983 to collect and prevent the spread of contaminated groundwater. Subsequent well samples around the former sludge area have shown decreased contamination and, because the source has been removed, the concentrations in these wells are expected to return to background levels. In order to confirm this, the NRC will require continued monitoring for radioactivity in the Z series wells and the staff will recommend that the state continue requiring nonradiological analyses for these well samples.

Table 4.12 Annual average nonradiological monitoring results for the Z series wells for 1978-1983

| Well | Year | Nitrates (ppm) | Ammonia (ppm) |
|---|---|---|---|
| ZB | 1978 | 0.2 | 0.2 |
| | 1979 | 1105 | 18.9 |
| | 1980 | 1260 | 33.4 |
| | 1981 | 1078 | 43.3 |
| | 1982 | 108 | 3.9 |
| | 1983 | 44 | 3.0 |
| ZC | 1978 | 476 | 3.2 |
| | 1979 | 506 | 19.3 |
| | 1980 | 188 | 6.5 |
| | 1981 | 494 | 17.9 |
| | 1982 | 183 | 12.9 |
| | 1983 | 1568 | 53.7 |
| ZD | 1978 | 1.4 | 0.3 |
| | 1979 | 15.0 | 0.4 |
| | 1980 | 2.8 | 0.6 |
| | 1981 | 3.5 | 1.8 |
| | 1982 | 76.6 | 1.9 |
| | 1983 | 47.7 | 5.2 |
| ZE | 1978 | 0.3 | 0.1 |
| | 1979 | 9.6 | 0.8 |
| | 1980 | 666 | 16.1 |
| | 1981 | 193 | 11.2 |
| | 1982 | 730 | 12.4 |
| | 1983 | 964 | 16.0 |

Table 4.12 Continued

| Well | Year | Nitrates (ppm) | Ammonia (ppm) |
|---|---|---|---|
| ZF | 1978 | 0.7 | 2.0 |
| | 1979 | 46.0 | 2.5 |
| | 1980 | 1.0 | 0.9 |
| | 1981 | 0.6 | 1.6 |
| | 1982 | 2.2 | 1.0 |
| | 1983 | 3.1 | 3.8 |
| ZG | 1978 | 1005 | 1.1 |
| | 1979 | 140 | 4.4 |
| | 1980 | 1.0 | 1.1 |
| | 1981 | 7.1 | 2.2 |
| | 1982 | 4.9 | 0.7 |
| | 1983 | 1.0 | 1.2 |

Source: GE Environmental Report, NEDO-30153, 83 NED 051, July 1983 and GE submittal to the NRC dated February 10, 1984[6]

C. PL Series Wells

There are 12 shallow PL wells surrounding the final process lagoons, aeration basin, and 2 calcium fluoride storage pits. Because these wells have historically been free of contamination, the NRC and the state currently require GE to monitor only wells PL-1, 3, 5, 8, and 11. Nonradiological monitoring results for 1978 through 1983 are shown in Table 4.13. Well PL-8 contained fluoride concentrations above background during the entire period with a maximum value of 4.2 ppm. Fluoride levels in wells PL-10, 11 and 12 were in the 1-2 ppm range which is also sightly elevated. For comparison, releases of 8 ppm of fluoride in the liquid effluent stream are currently allowed in GE's NPDES permit and concentrations of 1 ppm fluoride are commonly used in drinking water supplies. No migration of radioactive material was detected in the PL wells until 1980 and 1981 in wells PL-10, 11, and 12. The maximum uranium concentration observed was 0.32 ppm (PL-11 in 1980), which is about half the average uranium concentration in the final process lagoons. Subsequent samples returned to background levels. Gross alpha analyses were added to the program in 1983 and available results show <18 pCi/l in well PL-11.

Table 4.13 Annual average nonradiological monitoring results for the PL series wells for 1978-1983

| Well | Year | Fluoride (ppm) | Nitrate (ppm) | Ammonia (ppm) |
|---|---|---|---|---|
| PL-1 | 1978 | 0.3 | 1.0 | 0.3 |
| | 1979 | 0.5 | 0.3 | 0.7 |
| | 1980 | 0.4 | 3.1 | 0.3 |

Table 4.13 Continued

| Well | Year | Fluoride (ppm) | Nitrate (ppm) | Ammonia (ppm) |
|---|---|---|---|---|
| | 1981 | 0.3 | 0.7 | 0.4 |
| | 1982 | 0.3 | 0.5 | 5.8 |
| | 1983 | 0.2 | 0.9 | 2.2 |
| PL-3 | 1978 | 0.1 | 3.7 | 0.2 |
| | 1979 | 0.1 | 1.7 | 0.2 |
| | 1980 | 0.3 | 7.4 | 0.4 |
| | 1981 | 0.1 | 2.7 | 4.1 |
| | 1982 | 0.1 | 2.4 | 0.1 |
| | 1983 | ---[a] | | |
| PL-5 | 1978 | 0.2 | 0.4 | 0.4 |
| | 1979 | 0.1 | 0.2 | 2.8 |
| | 1980 | 0.2 | 1.1 | 0.3 |
| | 1981 | 0.1 | 0.8 | 1.4 |
| | 1982 | 0.1 | 0.6 | 0.7 |
| | 1983 | 0.2 | 1.0 | 2.5 |
| PL-8 | 1978 | 4.0 | 0.6 | 0.4 |
| | 1979 | 2.6 | 1.4 | 2.2 |
| | 1980 | 2.9 | 7.6 | 1.1 |
| | 1981 | 2.5 | 1.4 | 1.2 |
| | 1982 | 2.5 | 1.5 | 0.9 |
| | 1983 | 3.3 | 0.9 | 2.7 |
| PL-11 | 1978 | 1.2 | 0.4 | 0.3 |
| | 1979 | 1.5 | 0.7 | 0.7 |
| | 1980 | 1.8 | 0.7 | 0.4 |
| | 1981 | 1.0 | 1.1 | 0.6 |
| | 1982 | 0.9 | 0.9 | 0.5 |
| | 1983 | 0.7 | 0.9 | 3.1 |

[a]PL-3 was dry during 1983

Source: GE Environmental Report, NEDO-30153, 83 NED 051, July 1983 and GE submittal to the NRC dated February 10, 1984[6]

Although these increases in contaminants are considered minor, future trends at the PL wells should be closely followed; however, GE reports that the PL wells were dry during the last 3 quarters of 1983 and samples were not collected. Other dry periods have been experienced at these wells and at other shallow monitoring wells at GE in the past. Therefore, the staff will require GE to continue sampling the PL wells and analyzing for radioactivity on a quarterly basis, but will require GE to take appropriate steps to obtain a sample from these and other shallow wells if prolonged dry periods are encountered (e.g., if a well is dry on two successive sampling occasions). Appropriate steps include attempting to sample at some other time, deepening the wells, or

installing new wells nearby without decreasing the effectiveness of the overall goundwater monitoring program.

D. CaF Series Wells

Four shallow wells (CaF series) surround the calcium fluoride storage area in the northwest corner of the site. No migration of uranium or fluoride from this area into the shallow aquifer was observed during the 1978-1983 period. All uranium results were below GE's limit of detection (0.01-0.02 ppm). The maximum gross alpha measurement at the CaF wells was <2.6 pCi/l. Fluoride concentrations remained at background levels with a maximum of 0.96 ppm fluoride. There is no trend of concern, except that the CaF wells were frequently dry prior to 1981. At that time, GE deepened the wells to facilitate sample collection. The staff will require GE to take similar action to assure sample collection from these wells if they remain dry for extended periods in the future.

E. Principal Aquifer Wells

GE is required to monitor the underlying principal aquifer at several points downgradient of potential sources of contamination. Well MW5, the combined water supply inlet, and individual supply well numbers 9, 11, and 14 are used to monitor the principal aquifer (Figure 3.3). Available results since 1978 show no contamination and no important trends. The maximum nitrate concentration observed was 1.6 ppm (well MW5 in 1983) which is well below the EPA's drinking water limit. Similarly, the maximum fluoride concentration, 0.46 ppm in 1983 at supply well 9, is representative of background and is lower than the fluoride concentration normally added to drinking water (1 ppm). Almost all uranium results for the principal aquifer were below GE's minimum detectable level of 0.02 ppm. Samples in May 1983 contained elevated uranium (a maximum of 0.14 ppm), but subsequent samples returned to background and the May results are unexplainable. In an inspection in 1982, the NRC analyzed samples from the plant site and found a maximum gross alpha concentration of 2.1 pCi/l.

GE currently monitors the individual supply well numbers 9, 11, and 14 for uranium and nonradiological contaminants in accordance with the state's NPDES permit. The NRC considers these wells to be in strategic positions to detect waste migration from the lagoons and/or the effluent drainage ditch. To ensure that the early warning provided by these wells is maintained, the NRC will incorporate radiological monitoring requirements at the wells into License SNM-1097. Accordingly, a condition will be added to the renewed license requiring GE to monitor supply wells 9, 11, and 14 for gross alpha and beta concentrations on a monthly basis. The staff will also recommend that the state continue appropriate nonradiological monitoring requirements at these wells. Monitoring at the individual supply wells will provide a better indication of the principal aquifer quality than is currently provided by monitoring the combined water supply inlet. Thus, the NRC's requirement to monitor the combined supply inlet will be discontinued.

As previously mentioned, newly adopted state standards for groundwater require compliance with quality criteria at depths of at least 20 feet.[20] The state will review GE's groundwater conditions and existing monitoring program and take appropriate action to ensure compliance with these standards and protection of the principal aquifer.

4.1.2.4 Soil Monitoring

In order to monitor the long term buildup of uranium in the surrounding environment, GE takes soil samples from 16 locations on and offsite and analyzes for uranium. There is generally an increasing trend in these results during the 1978-1982 period. This trend is the same at onsite sampling stations and at distant points up to 5 miles away, which are expected to be exposed to little (if any) of GE's airborne uranium emissions. Therefore, the increasing trend is not considered solely attributable to plant operations and may be the result of other sources. The maximum offsite concentration at a point within 1-2 miles of the site is low (.64 ppm which equates to 0.88 pCi/g at an enrichment of 2.5% $^{235}U$), but for future trend analyses the staff will require GE to continue this monitoring program.

There is a potential to accumulate uranium in the sediment of the liquid effluent drainage ditch. Sediment samples from the ditch are not routinely collected; however, occasional samples taken by GE upstream of the dam have contained uranium concentrations greater than 30 pCi/g, the limit for release of the GE site for unrestricted use (W. Smalley, GE, telephone communication with S. Wyngarden, February 15, 1984). GE indicates that occasional sediment samples from the ditch below the dam have contained less than 30 pCi/g. To better characterize the radiological nature of the sediments and to assess the trends, the staff will require GE to expand their existing soil monitoring program to include sampling for uranium in the sediment at several locations along the drainage ditch.

4.1.3 Mitigating Measures

The staff is concerned with groundwater contamination at GE and questions the adequacy of GE's existing monitoring program to provide an early warning of future releases. Since at least 1972, there have been recurring leaks resulting in contamination of the shallow aquifer immediately adjacent to waste treatment and storage areas. GE has taken steps to repair each leak as it occurred, including removing a major source of contamination (zirconium sludge) from the site. Following these actions, concentrations in adjacent wells have slowly trended towards background; however, the location and extent of contamination beyond this line of wells has not been determined. Groundwater in the water table aquifer moves toward the main site drainage ditch (Figure 3.2) where GE claims that it discharges and flows to the Northeast Cape Fear River. Depending on the continuity of the clay confining layer under this aquifer, some contamination may migrate downward into the principal aquifer. Figure 3.3 shows that water in the principal aquifer either moves toward the cone of depression created by supply wells in the northeast corner of the site or bends westward toward the river. Therefore, there are substantial buffer areas between the sources and potentially affected offsite areas and the staff expects that there is not an immediate threat of contamination moving offsite. To confirm this, however, GE's groundwater monitoring program must be expanded to define the plume and provide needed information for appropriate mitigative action. The staff will pursue this matter and strongly recommend that the state, under its authority of the newly adopted "2L" standards,[20] expand GE's groundwater monitoring requirements accordingly.

Residual groundwater contamination from past releases may have destroyed the effectiveness of the WT series wells to detect leaks from the waste treatment lagoons. Paved areas near the waste treatment facility limit recharge of the shallow aquifer in this area and groundwater and associated contamination move very slowly. Although the concentrations of contaminants in the WT wells have generally decreased in recent years, monthly results often increase to levels above background. Increases caused by a lagoon leak can not be easily distinguished from contamination moving downgradient from previous releases. Under these conditions, a leak could be allowed to persist before it is recognized and appropriate action is taken. Resulting contamination of underlying groundwater and soil could cause prolonged environmental impacts and complications at decommissioning time. In order to avoid these problems, the staff will recommend that GE and the state, which is the permitting authority for GE's lagoons, consider the installation of double liners and leak detection systems at the waste treatment facility lagoons. It will also be recommended that such systems be installed at the final process lagoons which are currently lined with compacted clay and allow an accumulation of contaminated sediment during their routine operation.

Except for these concerns about groundwater, routine operation of the GE fuel production facility is expected to result in small environmental impacts and no mitigatory measures are required. GE's effluent and environmental monitoring program will be continued in order to confirm this conclusion. To gain additional information and help identify the impacts of plant operation for future environmental assessments, six requirements will be added to GE's license. These are reviewed below.

Airborne fluoride can damage sensitive plant species and, if it has sufficiently accumulated in forage vegetation, cause fluorosis in grazing animals. Source term monitoring and dispersion calculations indicate that fluoride releases from all GE operations result in offsite concentrations that are within standards established in two states (New York and Washington) to protect vegetation, except possibly Washington's limit of 0.5 $\mu g/m^3$ for the growing season (Sect. 4.1.1.1(B)). Vegetation studies conducted by GE show a maximum fluoride concentration in pine needles that is well below the threshold for fluorosis, but the levels in possible forage have not been determined. To provide this information and to confirm GE's source term monitoring, GE will be required to semiannually monitor for fluoride in potential forage vegetation located onsite.

GE is currently required by license condition to report violations of their NPDES permit to the NRC. Such reporting keeps the NRC abreast of important environmental events and will be required to continue under the renewed license.

Contamination of sediments in the liquid effluent drainage ditch may require removal of the sediments during decommissioning and disposal under prescribed conditions. GE does not currently monitor the sediments on a routine basis. To obtain additional information on the uranium content of these sediments and to assess the trends, GE will be required to expand their soil monitoring program for uranium to include sampling stations in the effluent drainage ditch.

GE currently monitors supply well numbers 9, 11, and 14 for uranium in accordance with the state-issued NPDES permit. This permit is in the process of being renewed and modified and consultation with the state indicates that their future

monitoring requirements at these wells are uncertain. The NRC considers these wells to be in strategic monitoring positions. Therefore, to ensure continued monitoring at these wells, the NRC will require GE to monitor supply wells 9, 11, and 14 for gross alpha and beta on a monthly basis. Because GE's analytical sensitivity is much lower for gross alpha and beta than for uranium, these gross measurements will be more valuable in providing an early warning of potential contamination. With this monitoring of the principal aquifer at strategic locations, the monitoring requirement at the combined water supply inlet will be eliminated.

As mentioned in Section 4.1.2.3, several of the shallow wells specified for periodic monitoring are frequently dry. At present this is mainly a concern for the PL series wells and well WT-4. The staff considers the existing groundwater monitoring requirements at GE to be a minimum program and will not allow samples to be collected less frequently than currently specified. Accordingly, if any shallow well (WT, Z, PL, or CaF series) is found to be dry for extended periods, GE will be required to take appropriate steps so that a water sample can be taken. If changes in a well position are appropriate, only those changes that do not decrease the effectiveness of the overall groundwater monitoring program will be permitted.

GE only heats and vaporizes $UF_6$ inside the plant buildings and the possibility of a large outdoor release of $UF_6$ is very remote (Sect. 4.3.1.2(A)). The potential consequences of a large outdoor release of liquid $UF_6$ are unacceptable and, to further reduce the likelihood of its occurrence, a condition will be added to the license specifying that a cylinder containing liquid $UF_6$ will not be moved with the exception of those cylinders containing only residual quantities left after vaporization.

## 4.2 Direct Effects and Their Significance

### 4.2.1 Air Quality

As presented in Section 4.2.5, the calculated offsite doses resulting from GE's radiological airborne emissions are well below applicable limits. The environmental effects of the low concentrations of airborne radioactivity are also expected to be insignificant.

Normal operation of GE's fuel fabrication facility is not expected to have a significant effect on nonradiological air quality parameters. The State's Department of Natural Resources and Community Development has reviewed GE's process discharges and issued permits to operate air pollution control equipment for the different release points. Primary chemicals of concern are fluoride, ammonia, and nitrogen oxides. As discussed in Section 4.1.1.1, atmospheric dispersion calculations show that GE's fuel production activities result in negligible increases of fluoride in the ambient air. Combined fluoride releases from other GE operations result in slightly elevated concentrations and to provide additional information on this matter, GE will be required to monitor for fluoride in surrounding vegetation (Sect. 4.1.3). Dispersion calculations using GE's ammonia source term (16 lbs/hour)[3] yield 0.14 $\mu g/m^3$ of ammonia in air at the nearest site boundary. This concentration is less than 1% of the NIOSH/OSHA permissible exposure level of 35 $\mu g/m^3$.[16]

For NOx, the state limits GE to no visible emission and GE calculates a fence-line concentration of 0.03 ppm. The EPA standard for the annual average concentration of NOx in secondary air is 0.05 ppm.

4.2.2 Land Use

The main site development and construction activities occurred at the GE plant during 1966 and 1968. The environmental impacts of these activities have been ameliorated over the intervening years by landscaping in the developed areas and by reforestation efforts in undeveloped areas. Operation of the GE plant has had no adverse effects on land use in the past, and there are no plans to expand the facility. Therefore, no additional impacts on land use, historical sites, or floodplains and wetlands will result from license renewal. Any proposal for new facilities or expanded operations during the license renewal period will necessitate an evaluation of land use impacts. Additionally, there will be minimal impacts on future land use after decommissioning because the site will then be required to meet federal standards for unrestricted use.

4.2.3 Water

Direct effects on surface waters are controlled by requirements of GE's NPDES permit and NRC license. As discussed in Section 4.1.1.2, GE's liquid effluent during the 1978-1982 period met the applicable limits for radiological and non-radiological constituents at the point of release. Because these discharge limits are low and because the waste stream flow ($0.5 \times 10^6$ gallons/day from the process lagoons and $0.02 \times 10^6$ gallons/day of treated sanitary effluent) is very small compared to the average flow of the Northeast Cape Fear River ($635 \times 10^6$ gallons/day), significant impacts on the river are not expected. Using the maximum daily discharge of treated process wastes and the river's 10-year, 7-day low flow ($9.5 \times 10^6$ gallons/day), the maximum concentration increase in the river during the 1978-1982 period is 1.9 ppm of fluoride, 2.6 ppm of nitrogen combined as ammonia, nitrate, and nitrite, and less than 0.01 ppm of copper, nickel, and chromium. When compared to the average concentrations measured upstream, these concentrations are about a 10-fold increase in fluoride, a doubling of nitrogen compounds, and an insignificant increase in metals. The combination of circumstances resulting in such high concentrations is very unlikely and resulting impacts would probably be confined to the effluent mixing zone. Monitoring of the Northeast Cape Fear River has confirmed that released contaminants are not significantly impacting the river's water quality (Sect. 4.1.2.2).

As discussed in Sections 4.1.2.3 and 4.1.3, past releases have resulted in contamination of the shallow aquifer adjacent to waste treatment and storage facilities. The magnitude of this contamination has not been defined and the location of a plume, if any, is speculative. Contamination of the principal aquifer, which is a productive source of water for the area, has not been observed. The NRC recommends that GE use available onsite hydrogeological data to assess the environmental impacts of this contamination and will recommend that the state expand GE's monitoring requirements to provide needed information on this matter.

### 4.2.4 Ecological

Before construction of the GE facilities, the site was used for lumbering and farming. Only about 20% of the 1664 acre site has since been developed by GE and large portions of the undeveloped areas have been replanted with trees. This conversion of portions of the site to forest along with continued maintenance of onsite fields, ponds, and natural swamp lands has probably increased its value as wildlife habitat by providing additional food and cover for a variety of species.

Continued operation of the GE plant will have no significant impacts on terrestrial vegetation or wildlife other than the continued occupation of potential habitat by industrial facilities. Because no new construction in undeveloped areas is planned, there will be no additional loss of habitat. No threatened or endangered species are known to frequent the area (Sect. 3.7.3) and none should be affected by continued plant operation.

Because the liquid effluents generated by GE are small in quantity and the discharges conform to limits in the NPDES permit issued by the State of North Carolina, there should be no measureable impacts to the aquatic biota of the Northeast Cape Fear River in the vicinity of the plant. Water samples from Brickyard Creek (the onsite drainage ditch) have been taken by GE at locations within the swamp forest and analyzed for chemical parameters. The parameters examined (temperature, dissolved oxygen, pH, nitrogen, chloride, fluoride, and sulfate) were reported to be at acceptable levels for freshwater aquatic life and future plant operations are not expected to significantly impact this aquatic system in the swamp.

### 4.2.5 Radiological Impacts

The radiological impacts of the GE facility were assessed by calculating the maximum dose to the individual living at the nearest residence and to the local population living within an 80-km (50 mile) radius of the plant site. Where site-specific information was not available, assumptions that would tend to maximize the dose were used in the calculations. It is only when such conservative assumptions yield a dose near or exceeding the applicable limit that GE is required to obtain appropriate data for a more realistic evaluation. Except where specified, the term "dose" as referred to in this appraisal is actually a 50-year dose commitment for all exposures; that is, the total dose to the reference organ that will accrue from one year of intake of radionuclides during the remaining lifetime (50 years) of the individual.

The doses were calculated using radioactive effluent release rates measured at the GE plant. The gaseous and liquid effluent source terms used in the calculation were the average annual releases for the past 5 years shown in Tables 4.2 and 4.4, respectively. This equates to 1713 μCi/year of gross alpha activity released to the atmosphere and 0.25 Ci/year of gross alpha discharged to the Northeast Cape Fear River. Because the release to the atmosphere in 1978 was much greater than releases for the other years (Sect. 4.1.1.1), the 1713 μCi/year released to the air is not truly representative of annual releases for the period but is used anyway as a conservative source term.

For the airborne emissions, source terms are coupled with atmospheric dispersion factors (Table 3.4) generated using the Gaussian Plume Model and diffusion coefficients for Pasquill type turbulence as in Regulatory Guide 1.111.[11] Doses via significant pathways are determined based on models presented in Regulatory Guide 1.109[21] with the exception that for the inhalation and ingestion pathways, dose conversion factors for various organs were taken from NUREG/CR-0150 Volume 3.[22] The inhalation dose factors were produced using the ICRP Task Group Lung Model and depend on the particle size and solubility of released compounds. Because the particle size and solubility of GE's airborne emissions have not been determined (Sect. 4.1.2.1), conservative assumptions for these parameters have been made. Namely, the particles passing through HEPA filters are assumed to have an AMAD of 0.3 μm. The released particles are further assumed first, to be completely in an insoluble form to provide a maximum calculated lung dose for the inhalation pathway and then, completely in a soluble form to provide a maximum calculated bone dose for the ingestion pathway.

For the liquid effluents discharged into the site drainage ditch and then to the Northeast Cape Fear River, it was conservatively assumed that the uranium is in a soluble form. It was further assumed that the liquid release was only diluted by the river flow at the point of release to the Northeast Cape Fear River.

4.2.5.1 Doses to the Maximally Exposed Individual

The nearest residence to the GE plant is a single family house located about 600 meters (1,800 feet) south-southeast of the Fuel Manufacturing Building. For airborne emissions, the pathways considered in the individual dose estimates were: (a) direct irradiation from ground deposition, (b) immersion in the airborne plume, (c) direct inhalation, and (d) ingeston of vegetation, meat, and milk that are conservatively assumed to be produced at the nearest residence. For liquid effluents, the pathways include: (a) ingestion of aquatic food (fish and shellfish), and (b) direct irradiation from shoreline deposition. The Northeast Cape Fear River is not used as a drinking water supply downstream of the GE site so potable water was excluded as a possible exposure pathway. Similarly, swimming or submersion in water was excluded because the state has designated the river best suited for other uses besides bathing. The models and various assumptions involved in the above pathways can be referred to in greater detail in Regulatory Guide 1.109.[21] Table 4.14 summarizes the calculated maximum doses from airborne and liquid effluents to the nearest resident.

Even with the numerous conservative assumptions, the doses shown in Table 4.14 are well below 500 mrem/year to the total body, gonads, and bone marrow; 3000 mrem/year to the bone; and 1500 mrem/year to the other organs (designated in or derived from NRC regulations in 10 CFR Part 20). When the doses are compared to the EPA standards for uranium fuel cycle facilities (40 CFR Part 190), the total body dose is only about 0.5% of the limit of 25 mrem/year. The highest organ dose of 1.9 mrem to the lung is about 8% of the applicable EPA standard while the bone dose of 1.1 mrem is about 4% of the standard.

As shown in Table 4.14 , the critical pathway is through inhalation resulting in a maximum dose to the lung of 1.9 mrem/year. The above calculations assume a normal adult, but the staff has also considered a critical individual (an infant of 0-1 years of age) at the nearest residence. The lung dose to an

infant will be increased by a factor of about 1.9 which is equivalent to 3.4 mrem/year.[23] This dose is about 14% of the EPA's standard. Therefore, normal operation of the GE plant over the past 5 years has resulted in maximum annual doses at the nearest residence that are well below 40 CFR 190 limits. To ensure that future operations at GE also comply with these limits and in keeping with the principles of ALARA, GE is required by license to report to the NRC and take corrective action if their gaseous effluent exceeds 1250 μCi/quarter. This release rate has been previously determined to result in a lung dose of 7 mrem/year to an infant at the nearest residence.[24]

The maximum impact on an unrestricted area resulting from GE's emissions might be at the nearest site boundary (500 feet south of the fuel manufacturing building) rather than at the nearest residence. The $\chi/Q$ at this boundary is about a factor of 12 higher than the $\chi/Q$ at the nearest residence. Conservative calculations yield a maximum dose of 39 mrem/year at the boundary, which exceeds the EPA limit.

Table 4.14 Estimated maximum annual dose from airborne and liquid effluents to the nearest resident

| Pathway | Organ Dose (millirem/year) | | | |
|---|---|---|---|---|
| | Total Body | Lung | Bone | Kidney |
| Air Effluents | | | | |
| Direct irradiation | $1.7 \times 10^{-4}$ | - | - | - |
| Immersion in air | $2.3 \times 10^{-7}$ | $2.1 \times 10^{-7}$ | $3.0 \times 10^{-7}$ | $2.0 \times 10^{-7}$ |
| Direct inhalation[a] | $6.1 \times 10^{-2}$ | 1.9 | $1.8 \times 10^{-1}$ | $4.0 \times 10^{-2}$ |
| Ingestion | | | | |
| Vegetables[b] | $2.9 \times 10^{-2}$ | $8.7 \times 10^{-4}$ | $3.9 \times 10^{-1}$ | $8.6 \times 10^{-2}$ |
| Meat | $1.2 \times 10^{-4}$ | $3.5 \times 10^{-6}$ | $1.6 \times 10^{-3}$ | $3.5 \times 10^{-4}$ |
| Milk | $4.9 \times 10^{-4}$ | $1.5 \times 10^{-5}$ | $6.7 \times 10^{-3}$ | $1.4 \times 10^{-3}$ |
| Liquid Effluents | | | | |
| Potable water | No pathway | - | - | - |
| Submersion | No pathway | - | - | - |
| Aquatic food[c] | $4.2 \times 10^{-2}$ | $1.2 \times 10^{-3}$ | $5.6 \times 10^{-1}$ | $1.2 \times 10^{-1}$ |
| Shoreline deposition | $2.9 \times 10^{-4}$ | - | - | - |
| Total (millirem/yr) | $1.3 \times 10^{-1}$ | 1.9 | 1.1 | $2.5 \times 10^{-1}$ |

[a] Assumes 80% residence time.
[b] Includes leafy and non leafy vegetables. Since site-specific information is not available, it is assumed that 76% of the produce (non leafy) and 100% of the leafy vegetables consumed are grown at the nearest residence.
[c] Includes fish and shellfish.

Accordingly, in order to evaluate the real dose at the fenceline in case an individual were to move to this location, GE operates an ambient air sampler at the south property boundary (results reported in Table 4.7). Using the maximum average air concentration measured at this sampler for a year (1982)

and conservative assumptions concerning particle size and solubility, the calculated maximum dose to an infant at this site boundary would be 16 mrem/year. Although this dose is still below the EPA limit, GE is required by their license to inform the NRC if someone moves to the south boundary and to submit an estimate of the resultant change in dose commitments.

4.2.5.2 Doses to the Population Within 50 Miles of the Plant Site

The 1980 population within a 50 mile radius of the plant is shown in Tables 3.1 and 3.2. ALmost 370,000 people live within this area. Population doses were calculated based on the dose estimates at the nearest residence; the ratio of $\chi/Q$'s at the nearest residence and at various segments within the 50 mile radius, and the population in the corresponding segments. The population dose estimates considered the exposure pathways via airborne effluents. Because GE's liquid effluent is directed only to the Northeast Cape Fear River, the aquatic pathway is not significant in a 50 mile radius around the plant and was neglected. The population dose commitments from routine releases by GE are shown in Table 4.15. The natural background dose rate to the total body is 82 mrem/year along the North Carolina coastal plain,[25] which results in a population dose within 50 miles around GE of $3.0 \times 10^4$ man-rem. The total body dose rate of 0.15 man-rem shown in Table 4.15 is negligible compared to this background value.

Table 4.15 Dose commitments from airborne discharges to the population within 50 miles of the GE plant

| Pathway | Dose (Man-Rem)[a] | | | |
|---|---|---|---|---|
| | Total Body | Lung | Bone | Kidney |
| Direct irradiation | $7.6 \times 10^{-4}$ | - | - | - |
| Immersion in air | $3.7 \times 10^{-7}$ | $3.4 \times 10^{-7}$ | $4.8 \times 10^{-7}$ | $3.2 \times 10^{-7}$ |
| Direct inhalation | $1.0 \times 10^{-1}$ | 3.2 | $3.0 \times 10^{-1}$ | $6.6 \times 10^{-2}$ |
| Ingestion[b] | $4.9 \times 10^{-2}$ | $1.4 \times 10^{-3}$ | $6.6 \times 10^{-1}$ | $1.4 \times 10^{-1}$ |
| Total (Man-rem) | $1.5 \times 10^{-1}$ | 3.2 | $9.6 \times 10^{-1}$ | $2.1 \times 10^{-1}$ |

[a] Assumes all adults.
[b] Ingestion of vegetables, meat and milk with the same radioactivity concentrations as the postulated food produced at the nearest residence.

4.3 Indirect Effects and Their Significance

4.3.1 Potential Effects of Accidents

The fabrication of nuclear fuel for light-water reactors involves the use of low-enriched uranium and various potentially dangerous chemicals. The location of the chemical storage facilities at the GE plant and the maximum quantities stored are shown in Figure 2.8. The purpose of this section is to assess the offsite impact of a spectrum of accidents resulting in the release of nonradiological chemicals or radioactive materials.

4.3.1.1 Nonradiological Accidents

Postulated nonradiological accidents would involve the uncontrolled release of chemicals outside their storage or process containment. Accidents of severity class 1 (typified by a leak in a pipe line or a small spill) are defined as operational incidents or those accidents which are likely to happen during the life of the plant. Accidents of this type have occurred inside the manufacturing buildings and have been quickly detected. The spills have been contained by isolating the line sections involved and by transferring the spilled liquids to the appropriate waste treatment system. Accidental spills occurring outside the buildings have also been detected quickly and treated in a similar manner.

Accidents of severity class 2 (typified by breaching of bulk chemical storage tanks) are defined as unusual accidents or those accidents which are unlikely to happen during the life of the plant. Accidents of severity class 3 (such as low probability catastrophic earthquakes) are defined as events that have not yet occurred in the nuclear manufacturing industry.

Table 4.16 lists the spectrum of accidents which can originate at different locations and involve different materials of the plant. The largest quantity of each material stored at the plant at any time is listed in the table, together with the type of accident (nonradiological, radiological, or criticality) and the degree of severity which would result in a significant emission. Transportation accidents are a category apart and have not been included in Table 4.16. The table also lists the possible dispersion paths and the characteristics of concern to be considered in the assessment of accident effects.

Minor, severity class 1 operational incidents have occurred inside or outside process buildings and have not resulted in a release to the offsite environment. For the outdoor chemical storage area, the postulated severity class 2 accidents are based on the assumption that the entire contents of a stored chemical are released. Therefore, in this assessment, there is no difference in source terms and effects on the environment between severity class 2 and severity class 3 accidents. The expected effects at the site boundaries of the release of total amounts of each chemical stored are as follows:

A. Anhydrous Ammonia - Potenatial accidents involving water failure, power failure, criticality, and explosion will not result in release of anhydrous ammonia, but a release from a fire could occur. The storage tanks for anhydrous ammonia are constructed of welded steel and are capable of withstanding an internal operating pressure of 265 psi. Pressure-relief valves are installed to prevent overpressure in case of fire.

Exposure of the storage vessel to an intense fire would result in operation of the relief valves, designed to bleed overpressure. The release would cease as the fire is extinguished. Ammonia vapors could reach 50% concentration in the release area. Vapors at the site boundary could be of such a concentration as to require isolation of the area and/or temporary evacuation of nearby residents. The vapors would have a pungent, suffocating odor which would force capable people away and aid in limiting exposures. The likelihood of the combination of accidents and atmospheric conditions that would require evacuation is very remote.

Table 4.16 Spectrum of accidents

| Material | Largest Quantity Stored (lbs[a]) | Type of Accident[b] | Severity Class | Dispersion Path[c] | Characteristics of Concern |
|---|---|---|---|---|---|
| Anhydrous Ammonia | 124,000 | NR | 2,3 | W,A | $NH_3$ |
| Aqueous Ammonia | 150,000 | NR | 2,3 | W,A | $NH_3$ |
| Hydrofluoric Acid | 73,000 | NR | 2,3 | W,A | HF |
| Hydrochloric Acid | 67,000 | NR | 2,3 | W,A | HCI |
| Nitric Acid | 68,000 | NR | 2,3 | W | $HNO_3$ |
| Sodium Hydroxide | 89,000 | NR | 2,3 | W | NaOH |
| $UF_6$ | 1,000,000 | NR, R, C | 2,3 | A | U, HF, Radiation |
| $UO_2$ | 1,000,000 | NR, R, C | 2,3 | A | U, Radiation |
| Ammonium Nitr... Uranium in La... | 23,000,000 | NR | 3 | W | $NH_4NO_3$,U |
| Calcium Fluo... Ammonia/Uranium in Lagoons | 23,000,000 | NR | 3 | W | $NU_3$, F, U |
| Process Materials in Buildings | - | NR, R, C | 3 | W,A | Chemicals, Radiation |

[a]Includes Weight of Associated Water; [b]NR = Nonradiological, R = Radiological, C = Criticality; [c]W = Water, A = Air

B. Aqueous Ammonia - Potential accidents involving water failure, power failure, criticality, and fire are not applicable. The storage tanks are isolated, self-contained, and independent of water supply and electrical power. They are also protected by a dike and would not be affected by fire; however, projectiles from an adjacent explosion could puncture the tank resulting in discharge of a portion of the contents into the diked area.

Aqueous ammonia is stored onsite as a 29.4 percent concentration of ammonia. It is anticipated that the airborne concentration in the spill area would be less than 1000 ppm. The airborne concentration at the site boundary would be substantially less and would not, in all likelihood, require any protective measures such as isolation or evacuation.

C. Hydrofluoric Acid (HF) - HF is stored in a self-contained, diked, butyl-lined, steel tank. Potential accidents involving power failure, water failure, and fire do not apply. However, projectiles from an explosion could pierce the tank wall, resulting in a release of part of the tank contents into the diked area. The liquid would be retained and pumped into trailers or available storage. Vapor concentrations of HF at the site boundary could exceed the permissable exposure limit of 3 ppm set by NIOSH/OSHA,[16] although the likelihood of such an event is very remote.

D. Hydrochloric Acid (HCL) - HCL is stored in a lined steel tank contained within an outer acid-resistant tank. The only conceivable major accident would be a projectile from a nearby explosion penetrating the tank and outer tank allowing the contents to be released. The tank areas are curbed and graded so that a release of this solution would flow into a drain system and be impounded in the final process lagoons. The impounded material would be neutralized and released to the river over a several day period.

If the entire contents of the HCL storage tank were released in 1 day, assuming no dilution in the drainage ditch and average river flow, the resultant increase in river chloride concentration would be 12 ppm. The Northeast Cape Fear River often contains local concentrations of several hundred ppm from natural causes.

E. Nitric Acid - A release of all the nitric acid solution from the storage tanks would also be directed to the final process lagoons, where the material would be neutralized and then gradually released to the river. Under conditions of average river flow, release over 7 days could result in an increase of 2 ppm in nitrate concentration in the river. This temporary increase is within the normal ranges measured at the upstream sampling station and is not expected to have a significant effect on the river water quality.

F. Sodium Hydroxide - Release of all sodium hydroxide in storage would result in a discharge to the lagoons. The material would be neutralized using additional sulfuric acid and the contaminated water would be discharged over a period of several days to prevent adverse impacts to the river.

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[a]The level immediately dangerous to life and health.

The other significant nonradiological accidents listed in Table 4.16 involve the materials in the process buildings and the lagoons. Within the process buildings, a class 3 accident would have effects similar to those of the accidents of severity class 2 previously discussed. A very unlikely class 3 accident could result in catastrophic failure of a lagoon wall with subsequent discharge of the total lagoon content to the drainage ditch. The materials would be held in the ditch by closing the dam and then gradually discharged to the river.

The largest lagoons are the calcium fluoride lagoons, each containing up to 4 million gallons of treated waste water and calcium fluoride sludge. The bulk of the ammonia and fluoride has been removed from the liquid prior to entering the lagoons. According to GE, each million gallons of the liquid in a calcium fluoride lagoon contains about 100 pounds of ammonia and about 100 pounds of fluorides. If containment of this material failed, the liquid and associated sludge would flow onto the adjacent land and into the drainage ditches around the lagoons. The spilled liquids in the ditches would flow to the main site drainage ditch and be impounded by the dam for treatment and gradual discharge to the river. A release of the total contents over 7 days to the river would result in insignificant increases in ammonia and fluoride concentrations (<0.01 ppm). Some liquids not entering the ditch would seep into the groundwater. Whatever sludge flowed out of the lagoon would remain on the ground until cleanup with minimal, if any, dispersion.

4.3.1.2 Radiological Accidents

The accident analyses performed in support of this EIA have been limited to consideration of severe industrial type accidents that could potentially result in the release of large quantities of uranium from a $UF_6$ cylinder, and of the possible consequences that may result from a criticality accident, a major fire within the plant, and a transportation accident.

A. $UF_6$ Release

Shipping cylinders containing about 2200 kg of $UF_6$ are stored either inside the fuel manufacturing building or in a secured outdoor area. The $UF_6$ is a solid at ambient temperatures (sublimes at 132°F) and, at GE, is only heated and vaporized inside. Therefore, the possibility of an outdoor release of liquid $UF_6$ is extremely remote and such an accident is discredited. If a cylinder of solid $UF_6$ were to fail outside, for whatever reason, the $UF_6$ would vaporize very slowly. Because $UF_6$ reacts with atmospheric moisture to form uranyl fluoride ($UO_2F_2$) which is a nonvolatile solid, such a leak would tend to be self-sealing. The potential offsite doses resulting from a large failure of a $UF_6$ cylinder while stored outside at GE were previously estimated in another environmental impact appraisal.[26] Conservative calculations yielded maximum organ doses of 0.62 mrem to the bone for an individual at the nearest site boundary and 0.05 mrem to the bone for an individual at the nearest residence. This calculation assumed a release of 350 grams of soluble uranium in 15 minutes with a 1 μm AMAD. A ground level release was further assumed with no credit for a building wake effect.

In their recent environmental report, GE evaluated the outdoor release of a $UF_6$ cyliner's entire contents within one hour.[3] As previously mentioned, the

possibility of such an accident at GE is very remote and was only evaluated for a worst case analysis. Because the potential consequences of a large outdoor release of liquid $UF_6$ are unacceptable, the staff will take action to further reduce the likelihood of its occurrence. Accordingly, a condition will be added to GE's license specifying that a cylinder containing liquid $UF_6$ cannot be moved (inside or outside) with the exception of those cylinders containing only residual quantities of $UF_6$ left after vaporization. For a more realistic evaluation of a large $UF_6$ release, the staff has considered a leak of $UF_6$ indoors which is discussed below.

The $UF_6$ could be released as a liquid or vapor inside the fuel manufacturing building where the cylinders are heated. To provide a conservative evaluation of such an indoor release it is assumed that the entire contents of a $UF_6$ cylinder, 2200 kg, are released inside as a gas as a result of a valve failure during vaporization. Controls implemented by GE make the loss of a cylinder's entire contents very unlikely. Nevertheless, the release is assumed to occur in the GECO vaporization room, which has a volume of about 2300 $m^3$. Plant operations are typically conducted with the doors closed and most of the gas is expected to be initially contained indoors and principally in the vaporization room. The $UF_6$ gas will react with available water vapor, forming HF gas and particulate $UO_2F_2$. Under typical indoor air conditions, such as 20°C and 50% relative humidity (8.8 $g/m^3$ of water vapor), air concentrations in the vaporization room could reach 811 $g/m^3$ $UF_6$, 77 $g/m^3$ $UO_2F_2$, and 20 $g/m^3$ of HF. Some of these materials will seep outdoors and/or spread to other parts of the building. Additional quantities of $UO_2F_2$ and HF will be formed as the $UF_6$ reacts with water vapor in the rest of the building and with moisture entering the building by natural air exchange. Most of the $UO_2F_2$ (75% is assumed) would deposit on various indoor surfaces. Although some of the $UF_6$ will condense and also settle, it is assumed that it all remains airborne and either enters the ventilation system or escapes outside through available openings.

Ventilation in the GECO vaporization room exhausts about 85 $m^3$/minute resulting in 11 air changeouts per hour. It is assumed that 11 air changeouts or 1 hour is required to exhaust the airborne uranium. It is further assumed that the ventilation system filters and scrubbers operate at their design efficiency (about 99.9%) but, to account for the portion of material escaping through other than the ventilation system, 1% of the uranium is assumed to escape unfiltered and unscrubbed. Under these assumptions, approximately 246 g/minute of uranium will be emitted. Using a conservative $\chi/Q$ of $5.3 \times 10^{-4}$ sec/$m^3$ for accident analyses (from Reg. Guide 3.34[27]), the average uranium concentration at the nearest residence would be 2.2 $mg/m^3$, which at 2.5% enrichment equates to $3 \times 10^{-3}$ $\mu Ci/m^3$. The associated HF concentration would be 0.73 $mg/m^3$. After 1 hour, an adult at this location would receive through the inhalation pathway an effective total body dose commitment of 0.53 rem (assuming all insoluble $^{234}U$ with a 0.3 µm AMAD). The EPA has established guidelines to limit the exposure of an individual, as a result of a radiological accident, to 1 rem effective total body dose and 5 rem to the thyroid. The calculated total body dose from this postulated accident is 50% of the EPA's limit. Observations from past accidents indicate that the highest uranium intake a person can receive for a short period without experiencing serious consequences (from chemical toxicity) is between 2 and 6 mg.[23] An adult would inhale 2 mg during this hour which would not likely cause transient kidney damage. Similarly, the HF concentration is below recognized levels for respiratory discomfort.

The largest $UF_6$ release at GE occurred in 1978 within the fuel manufacturing building.[15] In this incident, the partial contents of a $UF_6$ cylinder were released in a vaporization chamber and subsequently into the room and ventilation system. The release occurred for about 30 minutes allowing roughly 253 kg of $UF_6$ (12% of the cylinder's entire contents) to be released. A portion of the $UF_6$ reacted with the scrubber water to form HF and, at some point while the release was ongoing, the HF destroyed one of the HEPA filters. As a result, approximately 1357 grams of uranium were released through the exhaust vent. This is equivalent to an activity of about 1800 μCi for uranium enriched to 1.7% in $^{235}U$ which was involved in the accident. Using meteorological data for the weather conditions at the time of release, the activity at the property boundary was calculated to be $4.5 \times 10^{-7}$ $\mu Ci/m^3$ which is less than the applicable maximum permissible concentration. Following this accident, corrective action was taken by GE to increase the capacity of the ventilation system scrubber and an additional ventilation system fresh air intake was installed. In the event of a similar incident, the added air intake would dilute the $UF_6$ and HF entering the ventilation system exhaust from the scrubber and improve the lifetime of the HEPA filters. Additional controls have been installed by GE to prevent a recurrence of significant $UF_6$ leaks including shut off valves, emergency cooling systems, and closure plugs in vaporization lines not in use. These added controls make the indoor release of a heated $UF_6$ cylinder's entire contents, like that postulated above, very unlikely.

B. Criticality Accident

The effects of a postulated criticality accident have been considered, although the possibility of such an accident at a low-enrichment uranium facility is remote. Historically, no accident of this kind has ever occurred in a low-enrichment fuel fabrication facility. Achievement of criticality with low-enriched uranium requires carefully controlled conditions and is not likely to happen accidentally. In addition, at the General Electric Wilmington Plant, programs of design, review, procedural control, engineered safeguards, and audits are implemented routinely to prevent a criticality accident of this kind.

The postulated criticality accident has the following characteristics (per Regulatory Guide 3.34[27]):

- The accident results in $10^{19}$ fissions produced in a series of pulses within a supercritical liquid system.
- The accident releases only the volatile fission products produced by the above number of fissions. At this time radioactive decay begins.

In the event of a criticality accident, an individual at the nearest residence (located 600 meters SSE of the fuel manufacturing building) would receive exposure from internal as well as external sources of radiation. The doses to an individual resulting from direct exposure to prompt neutron and gamma radiation, from submersion in a cloud containing beta- and gamma-emitting fission products, and from inhalation of the fission products in the cloud have been calculated in a previous EIA for the GE facility.[26]

The results of the calculations, which are considered conservative, indicate that an individual at the nearest residence would receive a gamma dose to the

whole body of 0.9 rem, a beta dose to the skin of 0.6 rem, and a dose to the thyroid of 2.6 rem. This thyroid dose is about 50% of EPA's 5 rem limit as the result of a radiological accident. These calculations assumed adverse meteorological conditions (a wind blowing at 1 m/sec under an F type of stability), a ground level release lasting 8 hours and a building wake effect.

C. Radiological Consequences of a Major Fire

A major fire could occur within the fuel manufacturing building that potentially could cause a release of radioactivity to the environment. In order to estimate the possible radiological consequences of a major fire, a scenario has been postulated describing the conditions that might occur during a hypothetical fire.

A fire, starting in the conversion area, burns with sufficient intensity to cause failure of the largest single storage hopper containing 500 kg of $UO_2$. The stored $UO_2$ reacts with air heated by the fire to form a fine powder of $U_3O_8$. Fifty percent of the $U_3O_8$ powder (250 kg) is released into the manufacturing building. The $U_3O_8$ and other combustion products from the fire are drawn into the plant ventilation system in sufficient quantities to plug the HEPA filters. Because the HEPA filters are designed to be fire resistant, the filters are not destroyed. The combined effects of lack of ventilation in the building and the combustion products generated by the fire cause the pressure in the building to rise slightly above atmospheric pressure. Some of the building air is forced out through the doorways and 1 percent of the uranium released from the storage hopper (2.5 kg) is, in turn, released at ground level. This quantity of uranium is about 17% of the uranium estimated to be released outside from the $UF_6$ leak discussed in Subsection 4.3.1.2(A). Accordingly, the nearest resident could receive a maximum organ dose of 0.43 rem to the lung.

D. Transportation Accident

Transportation accidents involving uranium-bearing materials or chemical process supplies could occur at or in proximity to the plant. The effects of such accidents should be smaller than those of similar accidents taking place in areas of higher population density. A vehicular accident involving a truck carrying uranium or chemicals has a low probability of occurrence ($10^{-6}$ per vehicle mile), and a much lower probability for extremely severe accidents ($10^{-13}$ per vehicle mile).

Truck shipments to the Wilmington Plant include the routine shipment of enriched $UF_6$ cylinders and process chemicals, and occasional shipment of radioactive material in other forms (such as returned unirradiated fuel rods). Shipments from the Wilmington Plant include the routine shipment of finished fuel assemblies, uranium dioxide powder, and uranium dioxide pellets as well as waste material shipped for offsite disposal at licensed waste burial grounds.

The worst possible transportation accident at the site involving the release of radioactive material would involve the rupture of a cylinder containing solid $UF_6$. During transport, the cylinders are contained within a protective overpack which makes a cylinder rupture very unlikely for most feasible transportation accidents. Nevertheless, the results of this accident would be the same as those discussed for the outdoor failure of a solid $UF_6$ cylinder (Subsection 4.3.1.2(A)).

4.3.1.3 Conclusions From Accident Analysis

The results of the accident analyses indicate that minor enviornmental impacts may occur as a consequence of a severity class 3 accident. The probability is low that such an accident would occur within the Wilmington Plant, and there is an even lower probability that the accident would occur simultaneously with the conservative conditions assumed as the bases for the accident analyses. Consequently, severity class 3 accidents are not expected to have significant impacts on the offsite environment. Severity class 1 and class 2 accidents are expected to occur occasionally with continued plant operations. The effects of these accidents are confined to the site and these accidents are not expected to endanger public health and safety.

4.3.2 Possible Conflicts Between the Proposed Action and the Objectives of of Federal, Regional, State and Local Plans and Policies

At this time, the staff is not aware of any conflict between the proposed action and the objectives of federal, regional, state, or local plans, policies, or controls for the action proposed as long as proper agencies are contacted, proper applications are submitted, and proper monitoring and mitigatory measures are taken to protect the environment and public health and safety.

4.3.3 Effects on Urban Quality, Historical and Cultural Resources, and Society

The environmental effects of the proposed license renewal action as discussed above are considered to be insignificant. The facility has not affected historical or cultural resources. The short-term social effects during operation are and will be minimal, and there will be minimal effects after decommissioning and reclamation because the site then will be required to meet federal standards for unrestricted use.

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